Department of Energy

ROCKY FLATS PROJECT OFFICE
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DEC 1 9 2005

05-DOE-00647

Mr. Carl Spreng
Rocky Flats Cleanup Agreement Project Coordinator
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Dear Mr. Spreng:

Please find enclosed for your information the Oak Ridge Institute for Science and Education Verification Survey Reports for Buildings 371, 374, 707, 771/774, and 776/777.

Questions concerning these reports may be directed to me at (303) 966-6246.

Sincerely,

John J. Rampe, Director
RFPO Project Management

Enclosures

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394

November 30, 2005

Mr. Ron Bostic
Rocky Flats Project Office
U.S. Department of Energy
10808 Hwy 93, Unit A
Golden, CO 80403

**SUBJECT: CONTRACT NO. DE-AC05-00OR22750
FINAL REPORT—VERIFICATION SURVEY OF THE FORMER BUILDING 371 CLOSURE PROJECT, ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN, COLORADO**

Dear Mr. Bostic:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has prepared the final report for the former Building 371 Closure Project, Rocky Flats Environmental Technology Site in Golden, Colorado. Comments provided on the draft report have been incorporated into the final report.

Please contact me at (865) 576-5321 or Scott Kirk at (865) 574-0685 should you need additional information.

Sincerely,

Phyllis C. Weaver
Health Physics/Project Leader
Environmental Survey and
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PW:db

cc: B. Wallin, K-H/RFETS
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File/407

The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. ORISE is managed by Oak Ridge Associated Universities. Established in 1946, ORAU is a consortium of 91 colleges and universities.

VERIFICATION SURVEY
OF THE
FORMER BUILDING 371 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Prepared by

P. C. Weaver

Environmental Survey and Site Assessment Program
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Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for the
Department of Energy

FINAL REPORT

NOVEMBER 2005

This report is based on work performed under contract number DE-AC05-00OR22750 with the U.S. Department of Energy.

VERIFICATION SURVEY
OF THE
FORMER BUILDING 371 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Prepared by: ______________________ Date: 11/22/05
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ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

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ABBREVIATIONS AND ACRONYMS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
CSV	central storage vault
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOP	Decommissioning Operations Plan
DQO	data quality objectives
ε_{Total}	Total Efficiency
ESSAP	Environmental Survey and Site Assessment Program
ft^2	square feet
FIDLER	Field Instrument for the Detection of Low-Energy Radiation
HVAC	heating, ventilation, and air conditioning
ITP	Intercomparison Testing Program
IV	independent verification
IVPP	Independent Verification Program Plan
IVT	independent verification team
JHA	job hazard analysis
K-H	Kaiser-Hill Company
KeV	kilo electron volts
m	meter
m^2	square meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
nCi/g	nanocuries per gram
NIST	National Institute of Science and Technology
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
PDS	pre-demolition survey
PDSR	pre-demolition survey report
RFPO	Rocky Flats Project Office
RFCP	Rocky Flats Closure Project
RFETS	Rocky Flats Environmental Technology Site
SU	survey units
WGP	weapons grade plutonium

VERIFICATION SURVEY
OF THE
FORMER BUILDING 371 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

INTRODUCTION AND SITE HISTORY

The Atomic Energy Commission, predecessor agency to the U.S. Department of Energy (DOE), selected the Rocky Flats site in 1951 to serve as a nuclear weapons component production facility. Production began in 1952 on both nuclear and non-nuclear components with the plutonium pits being the key component. Uranium and beryllium were also utilized in the production of various components and processes. Operations continued until 1989 when environmental and safety concerns temporarily halted operations. There were over 700 structures, such as process and support buildings, that were involved in the site's mission. In 1993, the production mission was permanently ended and a new mission to clean up the site by 2006 was initiated. The site has since been renamed as the Rocky Flats Environmental Technology Site (RFETS).

Kaiser-Hill Company, L.L.C. (K-H), is the DOE contractor responsible for closure of the RFETS by the year 2006. To meet the closure goal, K-H plans to characterize, remediate, perform pre-demolition surveys (PDS) and then demolish each building at the site. This process has been completed for Building 371 and associated support facilities and systems.

The DOE's Rocky Flats Project Office (RFPO) has the responsibility for oversight of closure at RFETS. The RFPO requested the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) to evaluate the basement and sub-basement slabs that will remain six feet below the final finish grade after building demolition.

SITE DESCRIPTION

The RFETS is located approximately 16 miles northwest of Denver, Colorado on State Highway 93 and Cactus Road. RFETS occupies approximately 385 acres within the 6,000-acre DOE reservation site (Figure 1). The site has been divided into two major operable units, the Industrial Area and the Buffer Zone. Building 371 was located in the northwestern quadrant of the Industrial area (Figure 2).

Building 371 was a four-level reinforced concrete structure containing approximately 315,000 ft^2 of floor space. Building 371 was used primarily for storage, stabilization, and packaging of plutonium, residues, and transuranic wastes. Level 1 was the sub-basement (Survey Areas C and D) which housed the lower part of the central storage vaults (CSV) and stacker retriever maintenance bay. Level 2 was the main basement area (Survey Areas E, F, and G). The basement housed the heating, ventilation, and air conditioning (HVAC) equipment and mechanical utilities. The basement also housed the upper portion of the CSV, maintenance bay, and a small plutonium processing area. Level 3 was the ground floor level and contained the vast majority of the plutonium recovery processing equipment. The Level 4 attic housed much of the building's systems (K-H 2003). Building 371 was designated as a Type 3 facility.

INDEPENDENT VERIFICATION OBJECTIVES

The primary objective of the independent verification (IV) survey was to implement the data quality objectives (DQO) as defined in the Independent Verification Program Plan (IVPP) (ORISE 2004a). The DQOs were designed to evaluate the PDS efforts in Building 371 against the applicable guideline criteria. Specifically, the Independent Verification Team (IVT) verified through the collection of direct gamma activity measurements that the Decontamination and Decommissioning (D&D) contractor complied with the objectives stated in the approved project-specific characterization plan and limits specified in the Building 371 Decommissioning Operations Plan (DOP) (K-H 2003).

IN-PROCESS INSPECTION

To expedite the D&D process, the IVT conducted Type A verification activities, the simpler type of verification consisting of document review, data validation, with potential confirmatory sample analyses. In addition, in-process and final status surveys for Type B verification, independent field measurements and sampling were also performed as needed. The in-process inspections followed the applicable lines of inquiry as outlined in Appendix A of the IVPP, as appropriate.

Type A verifications were implemented for areas in Building 371 with a low potential for radiological contamination (Phases II and III). Type B verifications were performed primarily in the Phase IV and V areas of Building 371 located six feet below final grade, including the sub-basement and central storage vault, and basement. Historical information and available radiological data were reviewed to ensure that the appropriate actions towards completion of pre-demolition activities had been performed.

DOCUMENT REVIEW

Document reviews of the contractor's PDS plans, sampling plans, and supporting data and documentation were performed. Type A reviews of the Pre-Demolition Survey Reports (PDSR) were performed for the Phase II areas of Building 371 which included area AP/AF; the Building 371 exterior; T376A; T371H, I, J, and K; and Building 376. A Type A verification was completed for Phase III of Building 371. Phase III included Area AP between Column Lines 1-12 and Column Lines T-Y, Building 373, and Cooling Tower 911. Data reviews were also conducted for survey areas D and E prior to performing verification surveys.

RADIOLOGICAL SURVEY PROCEDURES

Site verification activities were performed during the period March 21 to March 24, and April 25 to April 26, 2005 in each of five survey areas. ESSAP performed surface scans and gamma surface measurements in basement Survey Areas C and D and in the sub-basement Survey Areas E, F, and G (Figures 3 to 7). Scans and direct gamma measurements were performed using low-energy photon scintillation detectors. Survey activities were conducted in accordance with a project-specific plan (ORISE 2004b) submitted to and approved by DOE and supplemented by the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2004c and 2005a).

REFERENCE GRID

ESSAP utilized the reference system established by K-H and any prominent building features to identify measurement and sampling locations. Measurement and sampling locations were documented on detailed survey maps.

GAMMA SURFACE SCANS

Gamma scans were performed over 90 percent of accessible floor areas of the basement and sub-basement Survey Areas C, D, E, F, and G. The Survey Areas represented the portions of the concrete slab that existed greater than six feet below final grade, which will remain in place following building demolition. Gamma scans were performed using low-energy photon FIDLER detectors coupled to ratemeters with audible indicators. Any area of elevated activity identified during the scan that exceeded the field action level was flagged for further investigation.

GAMMA SURFACE MEASUREMENTS

Gamma surface activity measurements were performed at a minimum of 30 random/systematic locations per survey area. The number of systematic measurement locations was increased for survey areas with a higher potential for contamination. Direct gamma measurements were also performed at locations based upon: (1) areas that were identified by surface scans as having radiation levels greater than the field action level, (2) randomly generated measurement locations, and (3) at locations flagged as suspect. Measurements were performed when necessary to determine the average residual gamma surface activity in the contiguous square meter area. Direct gamma measurements were performed at 229 randomly selected locations and 12 judgmental locations (Figures 3-7). Judgmental locations are identified as B1, B2, etc. Additional measurements were performed to determine the square-meter average activity at five locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

The radionuclide of concern for Building 371 is 35 year old weapons grade plutonium (WGP) (Pu-239/240). Gamma surface activity measurements were converted to units of nCi/g for WGP based on the calculation method described in Rocky Flats technical basis document

05-RS-0002. The calculated concentration of isotopic plutonium was based on the Am-241 to Pu-239 ratio of 1:8. The results were compared to the 100 nCi/g concentration-based limit as averaged (defined as 0 to 1 cm concrete depth) over 1 m^2 (K-H 2004), as specified in the DOP.

Additional information concerning major instrumentation, sampling equipment, calculation variables, and analytical procedures is provided in Appendices A and B.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP reviewed various documents pertaining to the closure of Building 371 Closure Project such as the characterization plan, DOP, and the Phase II and Phase III PDSRs (K-H 2003, 2004, 2005b and c). ESSAP reviews of the PDSRs generated comments related to the classification of survey units. It was ESSAP's position that survey units (SU) 371066 and 371074 were initially misclassified based on information pertaining to historical use and proximity of the SU to Class 1 units. However, the review did not identify data in excess of the guideline criteria which would require reclassification. A review of the K-H PDSR overall results indicated that K-H performed adequate surveys and that any contamination identified was removed to levels meeting the guideline criteria (ORISE 2005b and c). Prior to initiating the verification surveys, ESSAP reviewed two data sets from Survey Areas D and E to prepare the survey strategy. The data did not identify any issues of concern or particular areas for expanded investigation (K-H 2005a).

GAMMA SURFACE SCANS

BASEMENT

Gamma surface scan results in Survey Area C ranged from 1,000 to 22,000 cpm. The highest activity was identified in the central area of Room 2310 which originally housed a large filter plenum. Scans were not performed in Survey Area D, except in the contiguous square meter area of direct measurement location 20 (B12).

SUB-BASEMENT

Gamma surface scans were performed on 80 to 100 percent of the accessible floor surfaces in Survey Area G of the sub-basement. A portion of Survey Area G was not accessible during the scanning period because of overhead work to remove Building 374. Also, surface scans were not performed in Survey Areas E and F except for in the immediate vicinity of a direct gamma measurement. Scan activity results ranged from 2500 cpm to 930,000 cpm. The highest levels were observed in the north central sub-basement in Rooms 1105, 1111, 1113, 1115, and 1119.

GAMMA SURFACE MEASUREMENTS

Locations that were at or exceeded the predetermined 250,000 cpm field action level were marked for additional investigation. Surface activity measurements were converted from cpm to nCi/g for comparison of surface activity to the concentration-based guideline criteria. FIDLER detectors coupled to ratemeter-scalers with audible output were used to perform gamma surface measurements.

BASEMENT

Gamma surface activity measurement results for basement Survey Areas C and D are provided in Tables 1 and 2, respectively. Surface activity measurements ranged from 610 to 1,600 cpm or 0.14 to 0.36 nCi/g for Survey Area C. In Survey Area D, the gamma surface measurements ranged from 960 cpm to 440,000 cpm. Final analytical data quantified this activity as 0.21 nCi/g and 99 nCi/g, respectively. The highest individual reading at location 20 (B12) was the only measurement that exceeded the 250,000 cpm action level. A five point measurement was performed in the contiguous 1 m^2 area that translated into a final concentration of 20 nCi/g.

SUB-BASEMENT

Gamma surface activity measurement results for sub-basement Survey Areas E, F, and G are provided in Tables 3 through 5. Surface activity measurements in Survey Area E ranged from 3,000 to 14,000 cpm (0.67 to 3.0 nCi/g). The surface activity measurements in Survey Area F, ranged from 4,200 to 75,000 cpm (0.92 to 17 nCi/g).

The area with the highest activity identified was in Survey Area G. Surface activity measurements ranged from 3,100 to 900,000 cpm (0.69 to 200 nCi/g). Eleven of the 70 measurements in this area were biased samples. Of the 11, four locations exceeded the action level (250,000 to 900,000 cpm); thereby, requiring additional investigation. A five point measurement was performed at each location to determine whether or not the average activity over 1 m^2 would satisfy the guideline criteria. After averaging, the highest remaining activity was 180,000 cpm or 41 nCi/g at location B11.

COMPARISON OF RESULTS WITH GUIDELINES

Final results were compared to the 100 nCi/g concentration-based limit as averaged over 1 m^2 of the first centimeter (cm) of concrete depth (K-H 2004). The calculated volumetric concentrations for individual gamma surface measurements ranged from 0.14 to 200 nCi/g. Five measurement locations exceeded the 250,000 cpm field action level. At each location, five point measurements were obtained for the purpose of averaging the activity over the contiguous 1 m^2 areas. All final concentrations were subsequently determined to be less than the DOP surface concentration limit of 100 nCi/g.

FOLLOW-UP ACTIONS AND CONCLUSIONS

The Type A reviews of the K-H PDSRs indicated that K-H performed adequate surveys and that any contamination identified was removed to meet the guideline criteria (ORISE 2005b and c).

During each ESSAP verification effort, K-H obtained comparison gamma surface measurements at each ESSAP measurement location. Furthermore, all locations were discussed and walked-down by K-H prior to ESSAP demobilizing from the site. Since K-H accompanied ESSAP during the collection of measurements, at the close of each survey effort, the ESSAP data points and K-H results were available during close-out. DOE and K-H management were presented with results and at that time any issues raised by ESSAP were addressed. K-H agreed to remediate the locations in the sub-basement that exceeded the 100 nCi/g prior to averaging.

Based upon the results of the ESSAP verification effort, all sub-grade slab surfaces greater than six feet below the final grade were below the 100 nCi/g concentration-based guideline. Therefore, it is ESSAP's position that the Building 371 Closure Project meets the DOE allowable contamination guidelines.

FIGURES

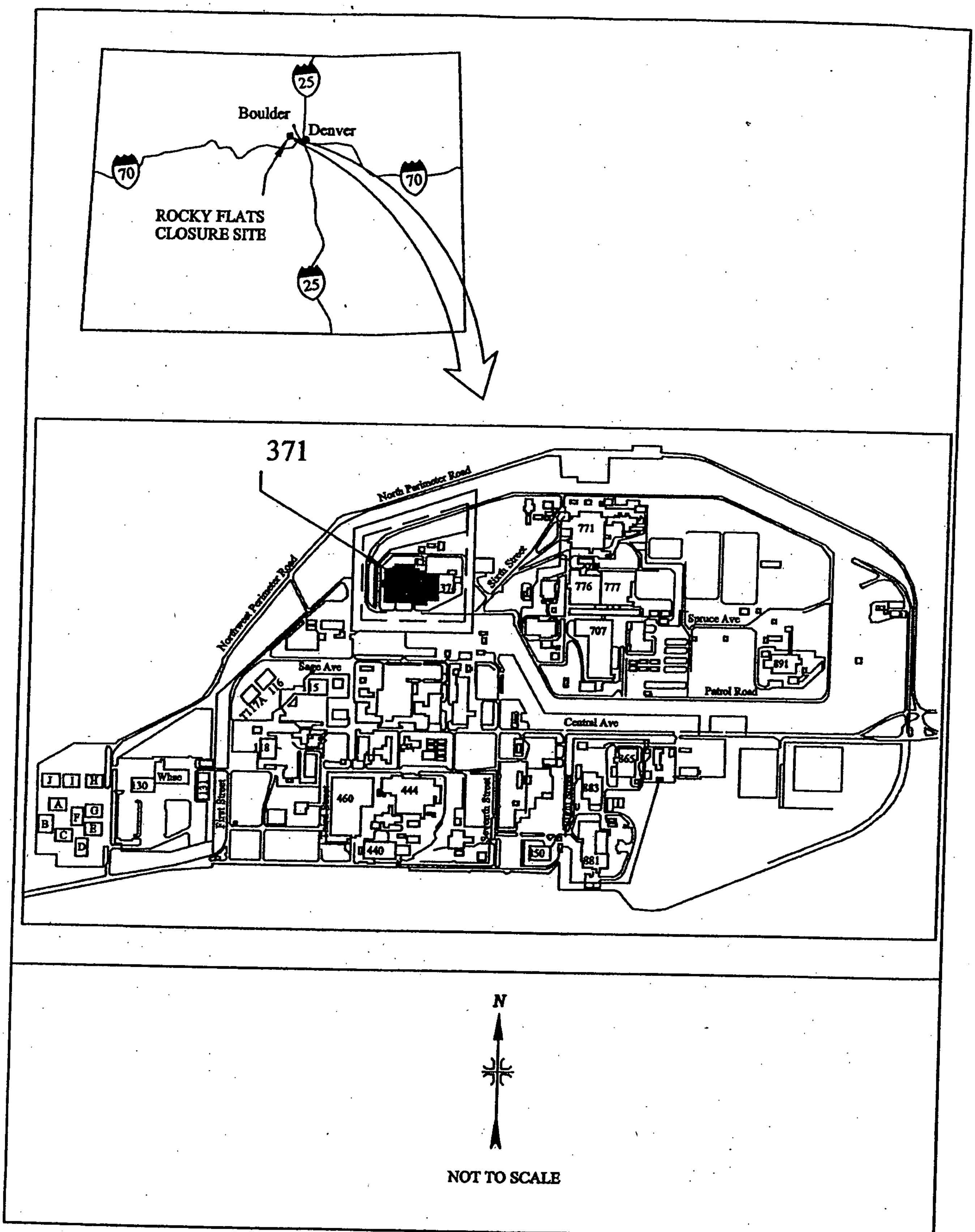

FIGURE 1: Location of the Rocky Flats Closure Site

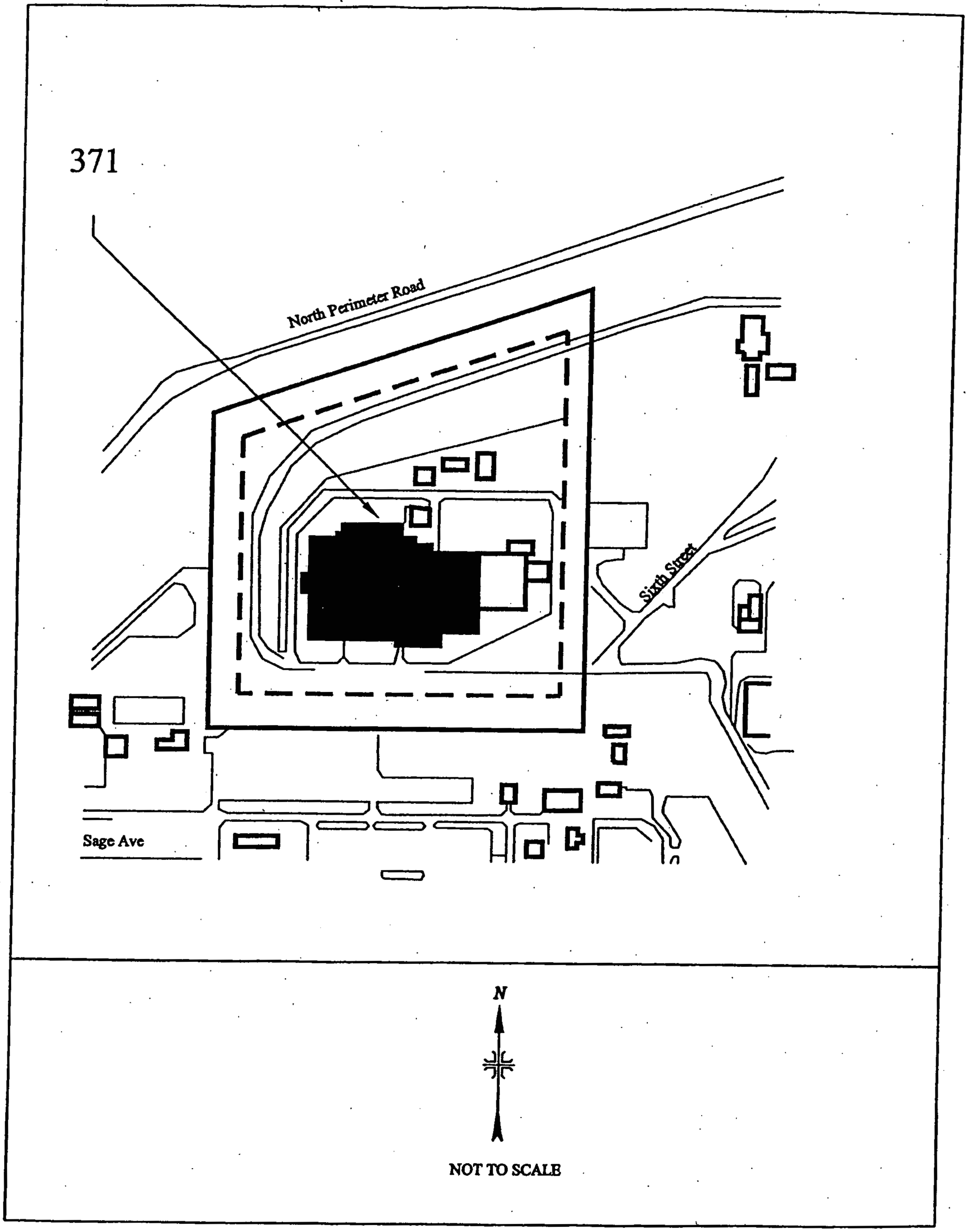

FIGURE 2: Location of the 371 Building

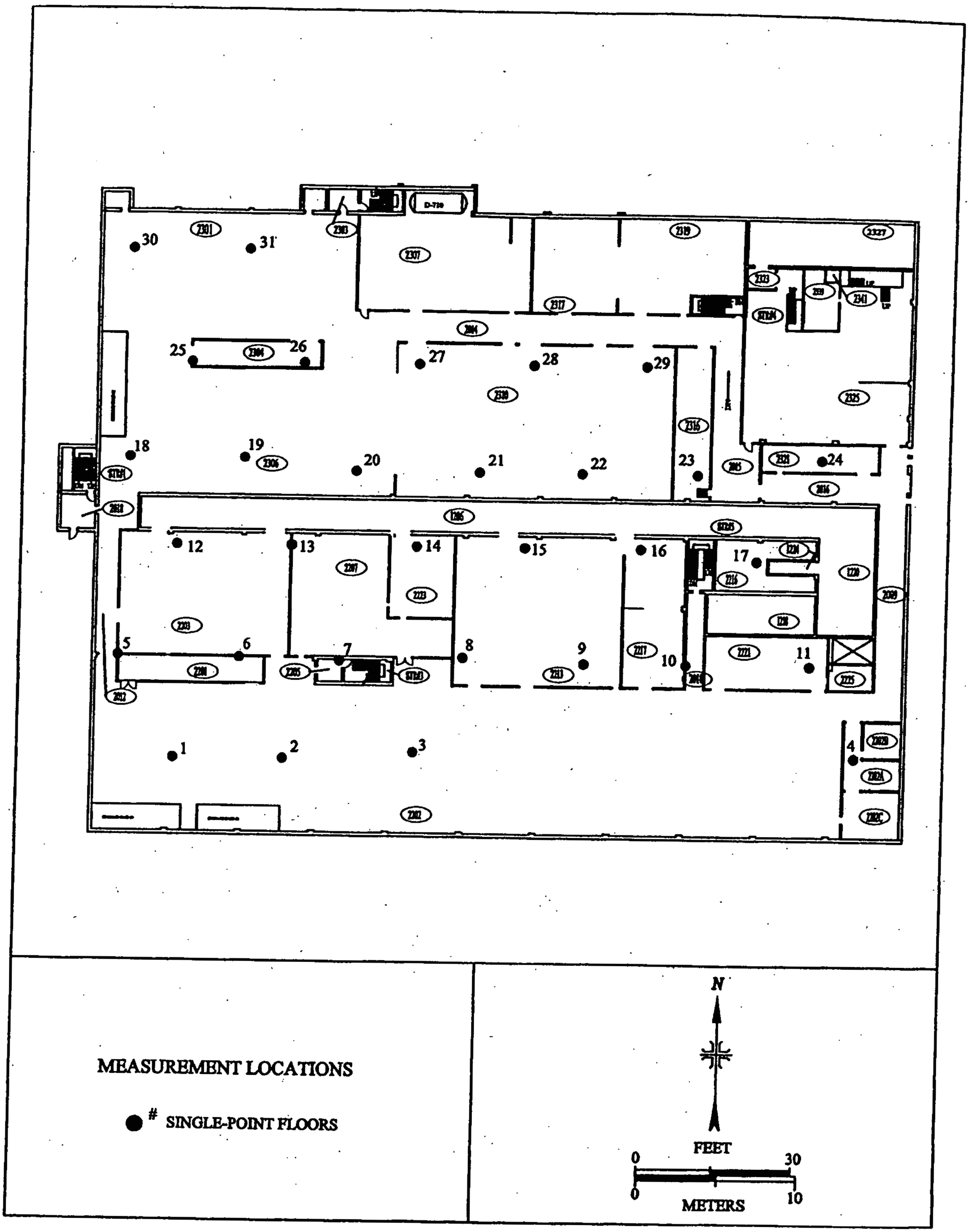

FIGURE 3: Building 371, Survey Area C - Measurement Locations

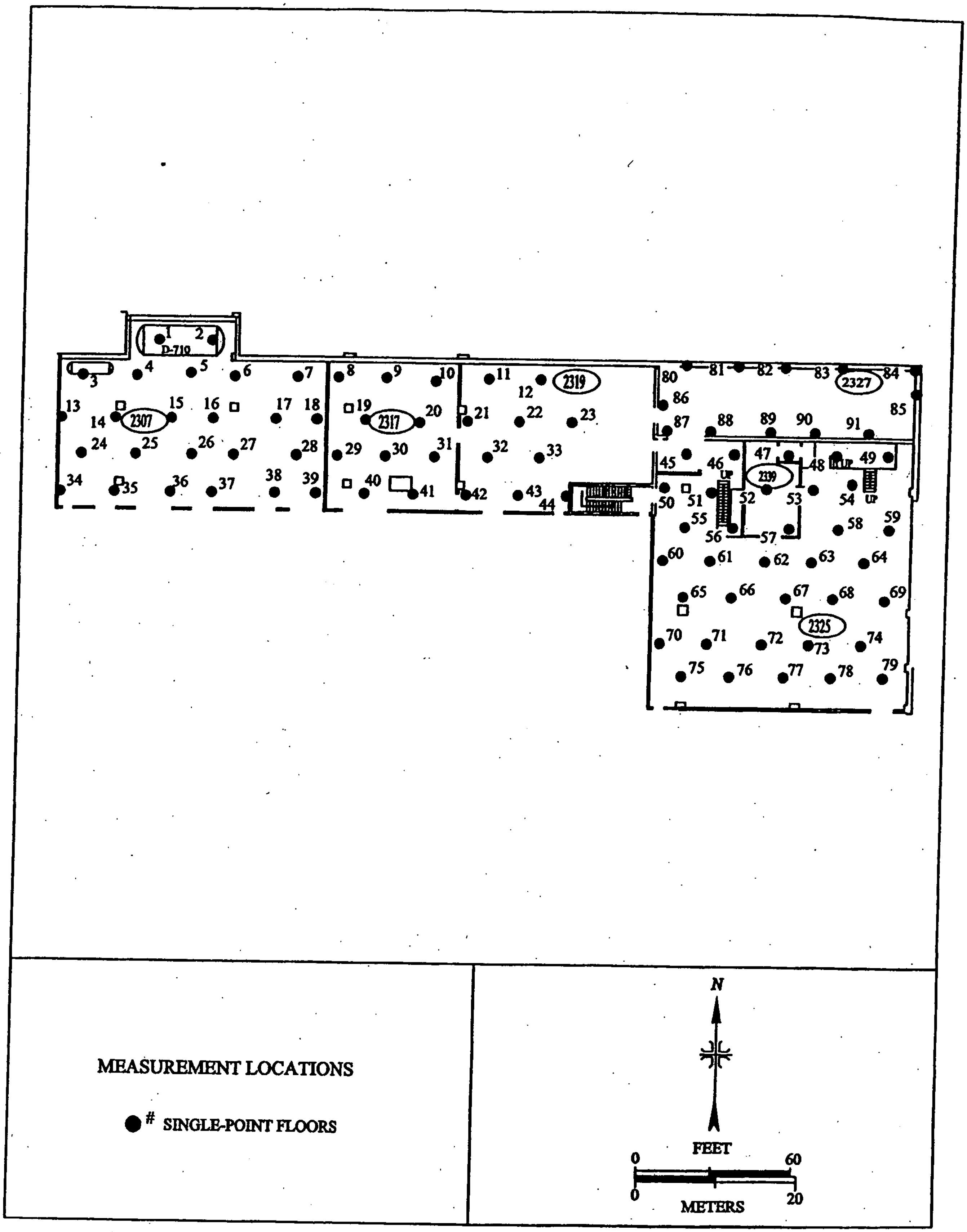

FIGURE 4: Building 371, Survey Area D - Measurement Locations

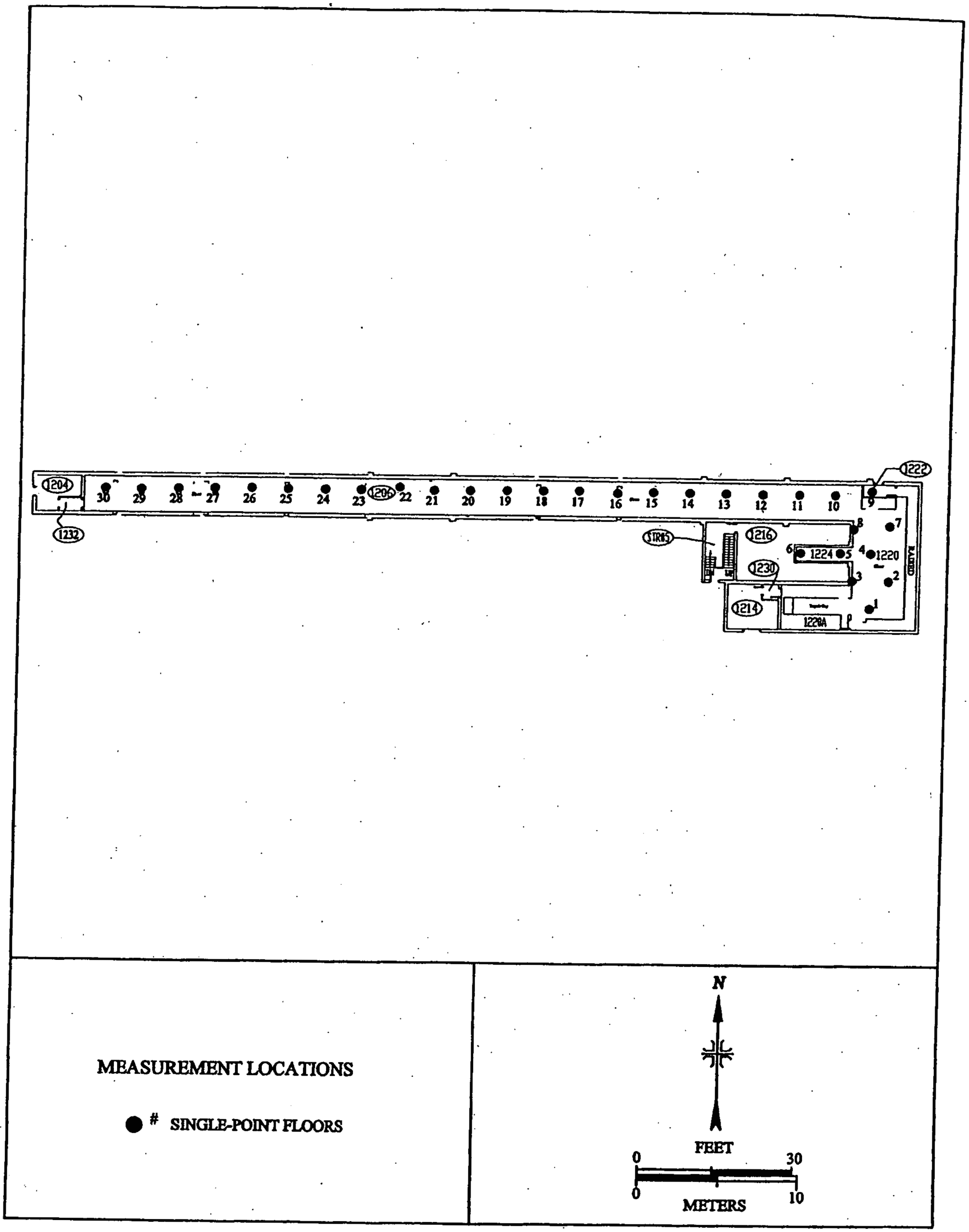

FIGURE 5: Building 371, Survey Area E - Measurement Locations

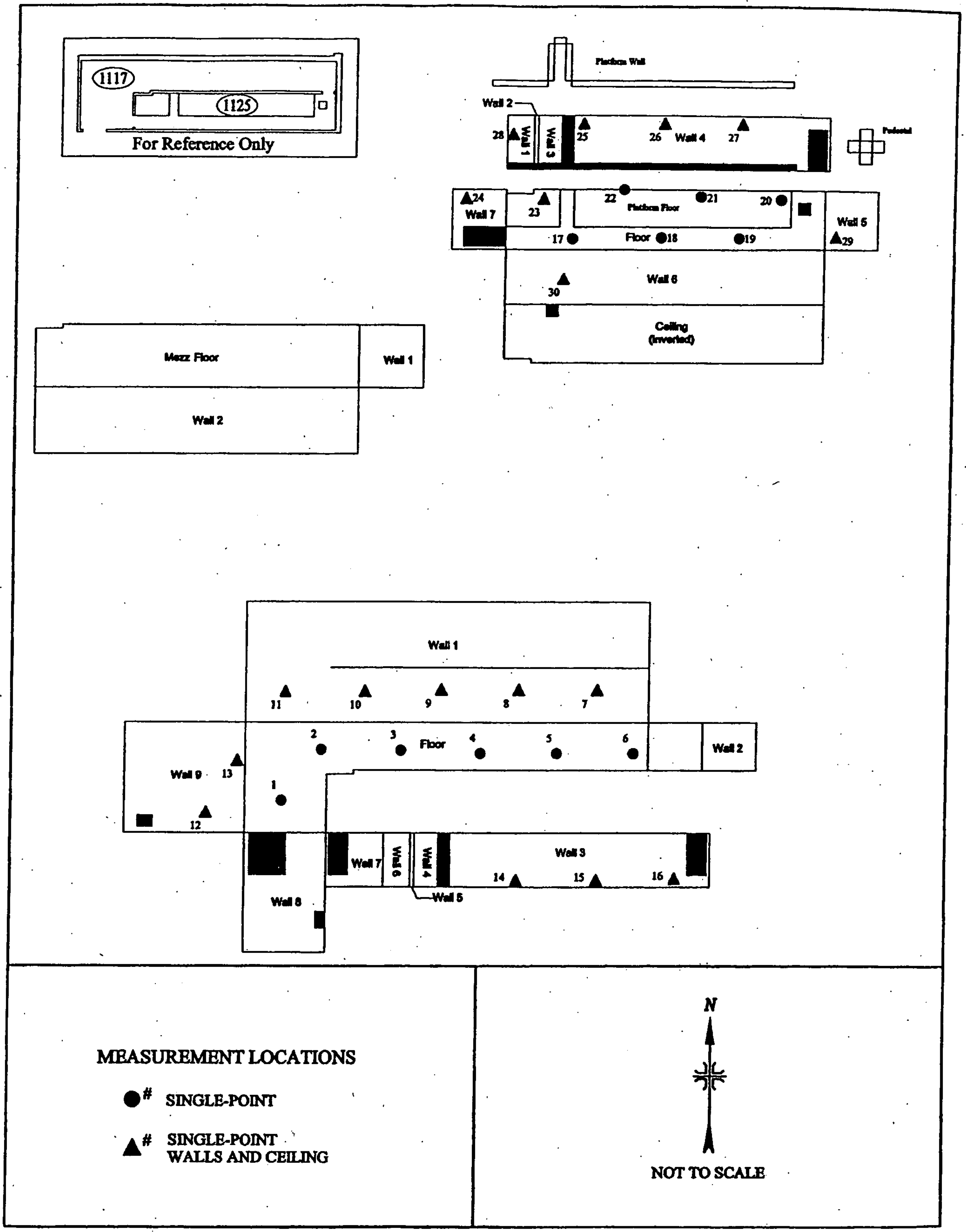

FIGURE 6: Building 371, Survey Area F - Measurement Locations

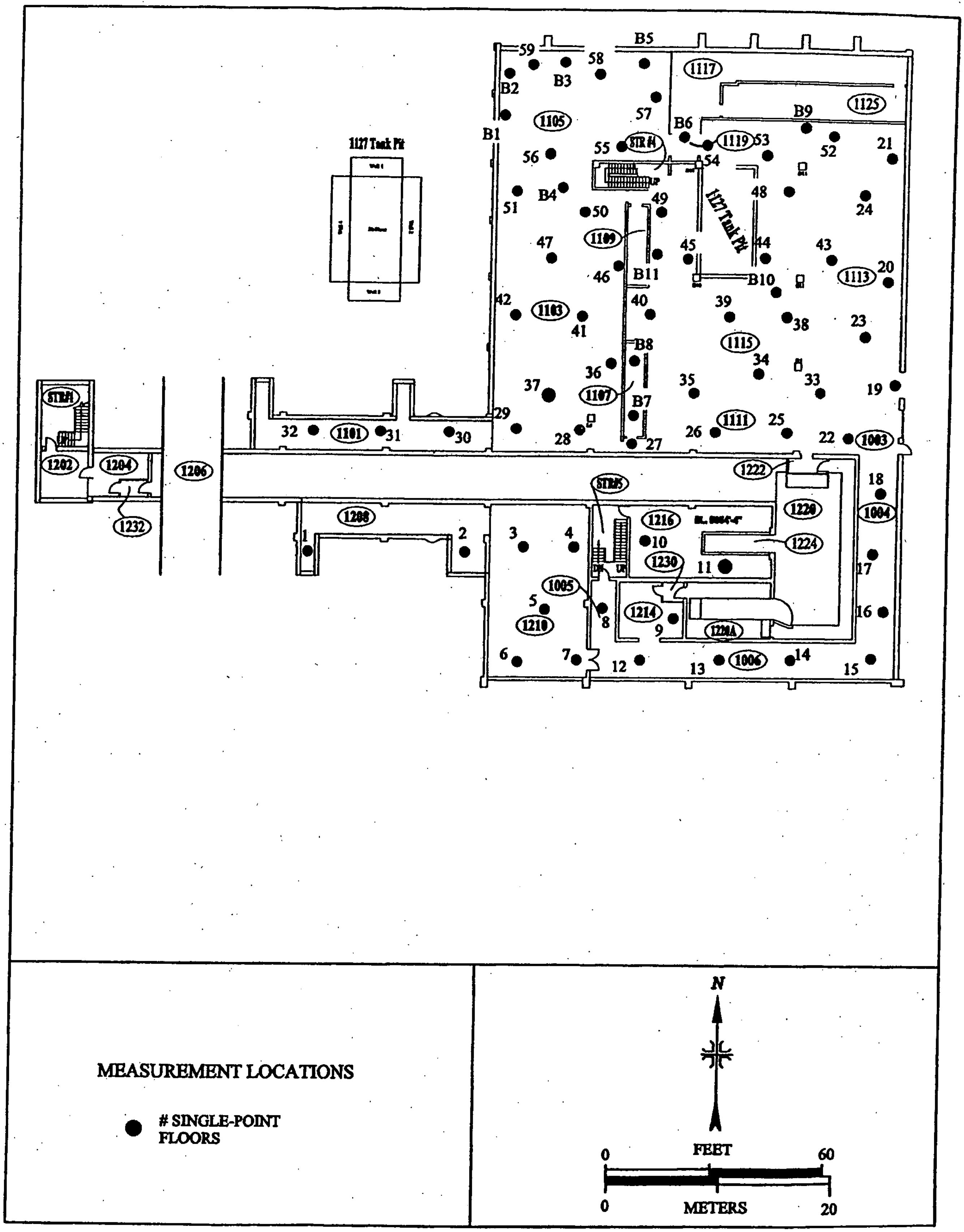

FIGURE 7: Building 371, Survey Area G - Measurement Locations

TABLES

TABLE 1

GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY AREA C
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
1	1,100	0.23
2	1,000	0.23
3	1,200	0.26
4	1,400	0.30
5	1,200	0.27
6	1,200	0.26
7	1,400	0.32
8	1,200	0.27
9	1,300	0.28
10	1,200	0.27
11	1,100	0.25
12	1,500	0.33
13	1,200	0.27
14	1,400	0.31
15	1,300	0.29
16	1,400	0.30
17	N/A[c]	N/A
18	1,300	0.28
19	1,000	0.23
20	610	0.14
21	1,300	0.28
22	1,300	0.28
23	1,300	0.29
24	1,200	0.28
25	720	0.16
26	920	0.20
27	1,600	0.36
28	1,200	0.27
29	970	0.21
30	1,300	0.28
31	1,100	0.25
Average Concentration (nCi/g)		0.20

[a]Refer to Figure 3
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.
[c]N/A-Measurement location not accessible.

TABLE 2

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA D ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
1	960	0.21
2	960	0.21
3	1,300	0.28
4	1,100	0.24
5	1,000	0.22
6	1,100	0.25
7	1,300	0.28
8	1,400	0.31
9	1,400	0.31
10	1,300	0.29
11	1,600	0.37
12	1,300	0.30
13	1,200	0.27
14	1,200	0.27
15	1,200	0.26
16	1,100	0.25
17	1,300	0.29
18	1,200	0.26
19	4,400	0.97
20 (B12)[c]	440,000	99
1 m^2 average at loc. 20[d]	90,000	20
21	1,500	0.33
22	1,400	0.30
23	1,700	0.37
24	1,100	0.25
25	1,100	0.25
26	1,100	0.25
27	1,100	0.25
28	1,200	0.27
29	150,000	34
30	1,400	0.32
31	1,300	0.29
32	1,600	0.35
33	1,400	0.32
34	1,100	0.25

TABLE 2 (Continued)

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA D ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
35	1,000	0.23
36	1,100	0.25
37	1,100	0.25
38	1,100	0.25
39	1,100	0.25
40	1,300	0.28
41	1,300	0.29
42	1,400	0.32
43	1,200	0.28
44	1,500	0.34
45	1,700	0.37
46	1,800	0.39
47	1,600	0.35
48	1,400	0.32
49	1,500	0.34
50	1,800	0.39
51	1,900	0.43
52	1,600	0.35
53	1,500	0.33
54	1,600	0.35
55	2,200	0.49
56	1,800	0.40
57	1,600	0.35
58	1,700	0.37
59	1,600	0.36
60	1,400	0.30
61	1,600	0.36
62	1,600	0.36
63	1,800	0.39
64	1,600	0.36
65	1,800	0.40
66	13,000	2.9
66 (0.3 NE of original)	31,000	6.9
67	1,800	0.39
68	1,400	0.32

TABLE 2 (Continued)

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA D ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
69	1,400	0.31
70	1,500	0.32
71	2,000	0.44
72	1,400	0.30
73	1,400	0.32
74	1,400	0.31
75	1,300	0.30
76	1,300	0.30
77	2,000	0.44
78	1,400	0.32
79	1,300	0.30
80	6,700	1.5
81	5,300	1.2
82	6,500	1.4
83	3,300	0.73
84	2,300	0.50
85	2,000	0.45
86	2,500	0.55
87	2,500	0.55
88	5,800	1.3
89	4,400	0.97
90	3,000	0.66
91	2,300	0.51
Average Concentration (nCi/g)		2.1

[a]Refer to Figure 4
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.
[c]Location 20 is a direct measurement location that exceeded the 250,000 cpm action level.
[d]Average consists of five measurements collected within the contiguous square meter area.

TABLE 3

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA E ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
1	4,700	1.0
2	4,800	1.1
3	6,300	1.4
4	4,600	1.0
5	3,000	0.67
6	3,300	0.74
7	5,700	1.3
8	14,000	3.0
9	4,100	0.92
10	6,000	1.3
11	5,000	1.1
12	5,200	1.2
13	5,100	1.1
14	5,300	1.2
15	4,700	1.0
16	5,000	1.1
17	5,700	1.3
18	5,100	1.1
19	6,800	1.5
20	6,500	1.5
21	6,100	1.4
22	9,000	2.0
23	6,000	1.3
24	7,100	1.6
25	5,400	1.2
26	4,900	1.1
27	4,600	1.0
28	4,600	1.0
29	4,500	0.99
30	4,600	1.0
Average Concentration (nCi/g)		0.95

[a]Refer to Figure 5
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.

TABLE 4

GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY AREA F
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
1	13,000	3.0
2	20,000	4.5
3	10,000	2.3
4	15,000	3.3
5	5,400	1.2
6	9,100	2.0
7	5,400	1.2
8	4,600	1.0
9	46,000	10
10	4,300	0.95
11	27,000	5.9
12	4,900	1.1
13	6,700	1.5
14	34,000	7.6
15	4,500	1.0
16	4,200	0.94
17	6,200	1.4
18	5,000	1.1
19	5,600	1.3
20	9,100	2.0
21	5,000	1.1
22	28,000	6.2
23	75,000	17
24	4,400	0.97
25	4,500	1.0
26	4,800	1.1
27	4,200	0.92
28	4,400	0.98
29	10,000	2.2
30	21,000	4.6
Average Concentration (nCi/g)		2.3

[a]Refer to Figure 6
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.

TABLE 5

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA G ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
B1	250,000	55
1 m^2 average at loc. B1[c]	53,000	12
B2	54,000	12
B3	40,000	8.9
B4	100,000	23
B5	62,000	14
B6	88,000	19
B7	97,000	22
B8	120,000	28
B9	260,000	57
1 m^2 average at loc. B9[c]	56,000	12
B10	640,000	140
1 m^2 average at loc. B10[c]	140,000	31
B11	900,000	200
1 m^2 average at loc. B11[c]	180,000	41
1	4,200	0.94
2	4,300	0.96
3	4,000	0.89
4	3,600	0.81
5	4,200	0.92
6	4,400	0.99
7	3,900	0.88
8	4,100	0.91
9	3,300	0.74
10	3,900	0.87
11	3,800	0.84
12	5,200	1.2
13	4,200	0.93
14	3,900	0.86
15	4,000	0.89
16	4,100	0.92
17	3,800	0.84
18	4,100	0.90
19	3,100	0.69
20	3,900	0.88

TABLE 5 (Continued)

GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY AREA G
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
21	4,900	1.1
22	4,100	0.92
23	3,300	0.72
24	5,000	1.1
25	4,300	0.95
26	4,500	1.0
27	3,700	0.81
28	4,400	0.98
29	4,400	0.97
30	4,200	0.92
31	4,200	0.93
32	4,100	0.91
33	4,700	1.1
34	4,300	0.95
35	4,600	1.0
36	4,200	0.93
37	4,400	0.97
38	5,000	1.1
39	4,800	1.1
40	5,300	1.2
41	4,200	0.93
42	4,200	0.94
43	4,400	0.98
44	3,900	0.86
45	4,200	0.93
46	4,300	0.96
47	4,300	0.96
48	4,100	0.90
49	3,800	0.84
50	4,100	0.92
51	4,300	0.95
52	7,200	1.6
53	4,200	0.93
54	20,000	4.4

TABLE 5 (Continued)

GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY AREA G
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
55	3,800	0.85
56	4,000	0.90
57	3,500	0.78
58	4,100	0.91
59	3,100	0.70
Average Concentration (nCi/g)		8.5

[a]Refer to Figure 7
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.
[c]Average consists of five measurements collected within contiguous square meter.

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APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Gamma

Ludlum Ratemeter-Scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to
BICRON NaI Scintillation Detector
Model G5 FIDLER
(Bicron Corporation, Newburg, OH)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

A walkdown of the project area was performed to evaluate the survey areas for potential health and safety issues that may not have been identified by the site. Additionally, the proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in applicable job hazard analyses (JHAs). The procedures entailed minimal potential hazards that were currently addressed in ESSAP JHAs.

Personnel adhered to the site health and safety requirements. Project training requirements were met prior to entry into the survey areas. General employee radiological training for site access was completed and the IVT completed beryllium worker qualification, including on-site physical, chest x-ray, and classroom lecture. In addition, the IVT received building specific entry and safety requirements. Confirmatory survey activities were conducted in areas that were not downposted for radiation or beryllium contamination and site dosimetric considerations were applicable.

QUALITY ASSURANCE

Calibration

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the ESSAP:

- Survey Procedures Manual (September 2004)
- Laboratory Procedures Manual (June 2005)
- Quality Assurance Manual (July 2005)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1C and the U.S. Nuclear Regulatory Commission

Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Instrumentation had to be re-calibrated at the site because of the effect of altitude on detection capability.

The gamma calibration efficiency for the FIDLER detector was determined to ISO-7503 recommendations. A NIST traceable Am-241 calibration source (maximum gamma energy of 59.5 KeV) was used to develop the optimal instrument efficiency using a 4 π source activity. The calculated ε_{total} ranged between 0.08 to 0.11 depending on the detector. The calibration source emission rates were corrected for geometry when a source larger than the detector was used.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detector slowly over the surface. The distance between the detectors and surface was maintained at a minimum, nominally about 1 cm. Surfaces were scanned using a low-energy photon FIDLER detector with a detector area 127 cm^2. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument.

Specific scan MDCs for the NaI scintillation detector for the radionuclide mixture in concrete were not determined as the instrument was used solely as a qualitative means to identify elevated gamma activity however, MDCs for radionuclides in the concrete would approximate those contained in NUREG-1507.

Surface Activity Measurements

Measurements for surface activity levels were primarily performed using gas proportional detectors with portable ratemeter-scalers. Surface activity measurements were performed on upper room surfaces, some equipment, and at locations of elevated direct radiation.
Gamma surface activity measurements were performed using the FIDLER detector. A Microshield ™ program calculation was performed based upon calibration variables and detector attributes to determine a field action level. The result calculated a field action level of 250,000 cpm that was used to conduct additional investigation.

Gamma count rates were integrated over one minute using the FIDLER. Count rates (cpm) were converted to nanocuries per gram (nCi/g) using the following equation:

$$\left(\frac{cpm}{\varepsilon_T * \varepsilon_p * 127cm^2}\right) * \left(\frac{127\ m^2}{W}\right) * \left(\frac{nCi}{2220dpm}\right) * 8\frac{Pu}{Am}$$

where:

ε_T = Total Efficiency = 0.08
ε_p = Attenuation Correction Factor for Painted Surfaces = 0.679

W = Volume * Density of Concrete = $127cm^2 * 1\ cm * 2.35\ g/cm^3 = 298.45\ g$

Note: Volume is calculated as physical detector area x DCGL depth

8 = ratio of Pu-239 to Am-241 for 35-year old WGP

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

November 30, 2005

Mr. Ron Bostic
Rocky Flats Project Office
U.S. Department of Energy
10808 Hwy 93, Unit A
Golden, CO 80403

**SUBJECT: CONTRACT NO. DE-AC05-00OR22750
FINAL REPORT—VERIFICATION SURVEY OF THE FORMER BUILDING 374 CLOSURE PROJECT, ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN, COLORADO**

Dear Mr. Bostic:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has prepared the final report for the former Building 374 Closure Project, Rocky Flats Environmental Technology Site in Golden, Colorado. Comments provided on the draft report have been incorporated into the final report.

Please contact me at (865) 576-5321 or Scott Kirk at (865) 574-0685 should you need additional information.

Sincerely,

Phyllis C. Weaver
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Environmental Survey and
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The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. ORISE is managed by Oak Ridge Associated Universities. Established in 1946, ORAU is a consortium of 91 colleges and universities.

VERIFICATION SURVEY
OF THE
FORMER BUILDING 374 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Prepared by

P. C. Weaver

Environmental Survey and Site Assessment Program
Radiological Safety, Assessments and Training
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for the

Department of Energy

FINAL REPORT

NOVEMBER 2005

This report is based on work performed under contract number DE-AC05-00OR22750 with the U.S. Department of Energy.

VERIFICATION SURVEY
OF THE
FORMER BUILDING 374
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN COLORADO

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ABBREVIATIONS AND ACRONYMS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DCGL	derived concentration guideline level
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOP	decommissioning operations plan
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQO	data quality objectives
ESSAP	Environmental Survey and Site Assessment Program
FIDLER	field instrument for the detection of low-energy radiation
ITP	Intercomparison Testing Program
IV	independent verification
IVPP	independent verification project plan
IVT	independent verification team
JHA	job hazard analysis
KeV	Kilo electron Volt
K-H	Kaiser-Hill Company
m	meter
m^2	square meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
mm	millimeter
MeV	million electron volts
mrem/yr	millirem per year
nCi/g	nanocuries per gram
NIST	National Institute of Science and Technology
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
PSP	project specific plan
PDS	pre-demolition survey
PDSR	pre-demolition survey report
RA	remedial action
RFETS	Rocky Flats Environmental Technology Site
RFPO	Rocky Flats Project Office
PRA	Post-remedial action
TSA	total surface activiey
ZnS	zinc sulfide

VERIFICATION SURVEY
OF THE
FORMER BUILDING 374 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

INTRODUCTION

The Atomic Energy Commission, predecessor agency to the U.S. Department of Energy (DOE), selected the Rocky Flats site in 1951 to serve as a nuclear weapons component production facility. Production began in 1952 on both nuclear and non-nuclear components with the plutonium pits being the key component. Uranium and beryllium were also utilized in the production of various components and processes. Operations continued until 1989 when environmental and safety concerns temporarily halted operations. There were over 700 structures, such as process and support buildings that were involved in the site's mission. In 1993, the production mission was permanently ended and a new mission to cleanup the site by 2006 was initiated. The site has since been renamed as the Rocky Flats Environmental Technology Site (RFETS).

Kaiser-Hill Company, L.L.C. (K-H), is the DOE contractor responsible for closure of the RFETS by the year 2006. To meet the closure goal, K-H characterized, remediated, performed pre-demolition surveys (PDS), and demolished each building at the site. This process has been completed for the Building 374 and the associated 3813 Dock Area.

The DOE's Rocky Flats Project Office (RFPO) has the responsibility for oversight of closure at RFETS. The RFPO requested the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) to: (1) conduct independent verification (IV) assessments in the former Building 374 of those surfaces to which the criteria for free release was applicable and (2) evaluate surfaces that will remain after building demolition located at six feet below the final finish grade.

SITE DESCRIPTION AND SITE HISTORY

The RFETS is located approximately 16 miles northwest of Denver, Colorado on State Highway 93 and Cactus Road. RFETS occupies approximately 385 acres within the 6,000-acre DOE reservation site (Figure 1). The site was divided into two major operable units: the Industrial Area and the Buffer Zone (Figure 2). All nuclear facilities at the site were within the boundaries of the Industrial Area.

Building 374 was designed and constructed in the 1970s in association with Building 371 to replace the plutonium pit assembly and pyrochemical operation in Building 776/777 and the residue and waste operations in Building 771/774. In 1981, the primary mission for these facilities was suspended with the exception of waste operations (K-H 2003). Building 374 was located adjacent to the east side of Building 371 and constructed of reinforced concrete. The building consisted of three levels: a main or first floor, mezzanine, and basement (Figure 3). Building 374 primarily housed tanks for receiving and storing liquid process wastes, a drum handling and storage area, and building support and mechanical equipment and utility area. The 3813 Dock was a later addition on the east end of 374 that was used for shipping and receiving miscellaneous waste and equipment from on-site processes (K-H 2004a). Building 374 was designated as a Type 3 facility.

INDEPENDENT VERIFICATION OBJECTIVES

The primary objective for independent verification survey of Building 371 was to implement the data quality objectives (DQO) as defined in the independent verification program plan (IVPP) to evaluate the pre-demolition survey (PDS) efforts in Building 374 against the applicable guideline criteria (ORISE 2004a). Specifically, the IVT collected total surface activity measurements, smear samples for removable activity, and direct gamma measurements to determine the adequacy of the Decontamination and Decommissioning (D&D) contractor's compliance with the objectives stated in the approved project-specific pre-demolition survey plan (ORISE 2004b).

DOCUMENT REVIEW

Document reviews of the contractor's PDS plans, sampling plans, and Pre-Demolition Survey Report (PDSR) supporting data were conducted by ESSAP. This documentation was used to develop the ESSAP project-specific survey plan, as well as assess and validate the overall results reported by K-H (ORISE 2004b).

A Type A review was implemented to evaluate the PDSR for the Building 374 3813 Dock. The review generated comments concerning inconsistencies in the presentation of the data as it related to subject documentation for survey methodology and survey results (ORISE 2004c). The overriding issue was a misapplication of Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance protocol in the classification or the non-reclassification of survey units based on sampling results (e.g., reclassification of a Class 2 area to Class 1 when contamination in excess of the DCGLs identified in the area). However, K-H took exception to the MARSSIM guidance based on the requirements in the site-specific Pre-Demolition Survey Plan.

The PDSR of the Building 374 interior was reviewed prior to Building 374 demolition which indicated that the levels of contamination identified during the characterization were remediated successfully to meet the guidance for unrestricted release (K-H 2005a). Furthermore, the PDSR indicated that scans, as well as direct measurements (statistically determined per MARSSIM protocol), were less than the derived concentration guideline levels (DCGLs) for free release (K-H 2003).

RADIOLOGICAL SURVEY PROCEDURES

Survey activities were conducted in accordance with a project-specific plan and supplemented by the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2004b d, and e). Site verification activities were performed during the period of January 17 through January 20, 2005. Verification surveys included low-energy gamma surface scans, alpha surface scans, and surface activity measurements. Instrumentation included a field instrument for the detection of low-energy radiation (FIDLER), gas proportional, dual phosphor and zinc sulfide

(ZnS) scintillator detectors coupled to ratemeter-scalers with audible output. Verification surveys were performed in each of the six Class 1 survey units and in seven Class 2 survey units.

REFERENCE GRID

The IVT used the survey unit reference system established by the D&D contractor to identify measurement locations. Measurement locations were documented on detailed survey maps and/or photographic records.

SURFACE SCANS

Alpha surface scan coverage for Class 1 survey units ranged from 75 to 100 percent in accessible areas and for Class 2 survey units, 25 to 75 percent of the accessible areas were surveyed. A lower percentage of scans (approximately 5 to 10 percent), were performed on overhead and upper surfaces. Scans were concentrated on areas such as ledges, support beams, and around penetrations or other openings through the ceiling. Gas proportional detectors or dual phosphor detectors coupled to ratemeter-scalers with audible indicators were used to perform alpha scans. Locations of elevated radiation were marked and identified for further investigation. Scans focused on areas such as ledges, support beams, and around penetrations or other openings through the ceiling

Gamma scans were performed over ninety percent of accessible floor areas in the DOP001, DOP002, and DOP003 survey units. All DOP units consisted of the concrete slab that remained after building demolition greater than six feet below final grade. Gamma scans were performed using a low-energy photon FIDLER detectors coupled to ratemeters with audible indicators. Any location identified during the scan was identified for further investigation.

SURFACE ACTIVITY MEASUREMENTS

Total surface activity (TSA) measurements for alpha activity were performed at 174 randomly selected and judgmental locations (Figures 4-8). At the request of DOE, two of the 174 measurements were obtained from the inlet and outlet of the filter plenum in DOP001 (Figure 4). When determined appropriate, a five-point measurement was made in the contiguous 1 m^2 area surrounding the location of elevated direct radiation to determine area average activity levels. TSA measurements were performed using gas proportional detectors or dual phosphor detectors coupled to ratemeter-scalers. A smear sample was collected at random and judgmental TSA measurement locations to determine the presence of any removable surface activity were selected.

Gamma surface measurements were performed to determine if the remaining building floor slab (at greater than six feet below final grade) would meet the surficial radionuclide concentration criteria. Thirty-one gamma surface activity measurements were obtained on the floor in survey units DOP001 through DOP003 (Figure 9). Gamma surface activity measurements were performed with the FIDLER detector coupled to a ratemeter-scaler.

MEDIA SAMPLES

Based on the identification of an area of elevated activity by ESSAP, K-H collected one media sample, constituting a 100 cm^2 stamp of concrete, from the west wall in Room 2804 survey unit (SU) 374001 in an area where a spill had occurred during the D&D process. The sample was collected to determine whether or not the contaminant was entrained in the concrete matrix. K-H obtained a gamma spectrum of the sample and followed up by decontaminating the location.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Smears were returned to the ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Analysis of smear samples was performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 2004f). Smear samples were analyzed for gross alpha activity using a low-background proportional counter. The results of field measurement data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2).

Direct alpha surface activity measurements were calculated based on an alpha efficiency as specified in ESSAP procedures (which are based on ISO-7503). ESSAP performs a 2π calibration, and multiplies that value by the surface efficiency, that results in total efficiency that is a 4π value.

Total gamma surface activity measurements were used to estimate the concentration of isotopic plutonium based on the Am-241 to Pu-239 ratio of 1:8. The radionuclide of concern for

Building 374 is 35 year old weapons grade plutonium (Pu-239/240). Gamma surface activity measurements were converted to units of nanocuries per gram (nCi/g) based on the calculation approach adapted from K-H (K-H 2005b). Additional information concerning major instrumentation, sampling equipment, calculation variables, and analytical procedures is provided in Appendices A and B.

Total and removable activity results presented in Tables 1 to 13 were compared to the following DOE Order 5400.5 surface activity guidelines (DOE 1993 and 1995):

<u>Total Activity</u>

100 α dpm/100 cm^2; 1,000 β dpm/100 cm^2, averaged over a 1 m^2 area

300 α dpm/100 cm^2; 3,000 β dpm/100 cm^2, maximum in a 100 cm^2 area

<u>Removable Activity</u>

20 α dpm/100 cm^2; 200 β dpm/100 cm^2

The concrete slab basement floor will remain in place at six feet below the final grade as indicated by survey results. Gamma surface activity measurements obtained by ESSAP were compared to the 100 nCi/g average surface (defined as 0 to 1 cm concrete depth) activity over 1 m^2 (K-H-2004b).

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP reviewed various documents pertaining to the closure of Building 374. ESSAP's review of the PDS Plan and Decommissioning Operations Plan (DOP), determined that the PDS was conducted in accordance with specified procedures (K-H 2005). Comments were provided for K-H to consider. A Type A letter report was prepared by ESSAP of the PDS Plan for Room 3813 Dock (ORISE 2004c). Conclusions reached by ESSAP from data cited in the PDS Plan for the 3813 Dock, indicated that the site release guidelines were met based on survey results and historical usage of the area.

SURFACE SCANS

Alpha scans were conducted to evaluate the potential for fixed activity. Alpha surface scans conducted in areas within the 6 feet above final grade (unrestricted release limits) resulted in a range of activity from 0 to 1,100 cpm. The highest alpha activity of 1,100 cpm was identified on a piece of support metal along the north wall in Room 2804 (Survey Unit 374001). Scans in 374003 (Class 2 area) identified several locations above the maximum guidelines. Further investigation by the IV team noted that many of the horizontal surfaces had not been wiped down as required. In the DOP areas 001 and 002, scans identified one area along the upper south wall of DOP002 (Room 2801) with TSAs ranging from 460 to 1,100 dpm/100 cm^2. Smears were collected to determine if removable activity would be significant and whether or not further investigation would be needed.

Gamma surface scan results for the DOP areas ranged from 2,400 cpm to 13,000 cpm with the highest levels detected in the two sumps located in DOP003 (Room 2804). Water had to be pumped from the sumps and the surface wiped down prior to obtaining actual measurements.

SURFACE ACTIVITY MEASUREMENTS

TSA measurements are reported in Tables 1 to 13. After the removal of a piece of metal support, the activities ranged from -14 to 8,000 dpm/100 cm^2. Of the 174 measurements, twenty-six measurements (15 percent) exceeded the 300 dpm/100 cm^2 maximum guideline. Areas with the highest total activity measurements were detected in Survey Units 374001 (Room 2804 along the north and west wall) and on the floor of Survey Units 374002 and 374006.

Five-point measurement evaluations were performed at fifteen locations to determine 1 m^2 average activity levels at locations that exceeded the average activity (Table 14). The average activity ranged from 40 to 330 dpm/100 cm^2. Eleven of the fourteen locations (78 percent) exceeded the average of 100 dpm/100 cm^2. Measurements for total alpha obtained in the DOP001 and DOP002 survey areas identified three locations having surface activity exceeding the hot spot criteria. Each location was smeared and re-measured to determine if contamination exceeded removable activity guideline levels. Removable alpha activity ranged from

0 to 80 dpm/100 cm^2. The 80 dpm/100 cm^2 activity that exceeded the removable criteria was collected from the inlet side of the filter plenum in DOP001.

Surface activity measurements on the concrete slab in DOP areas 001 through 003 were compared to a field action level of 250,000 cpm that is roughly equivalent to the 100 nCi/g surface activity averaged over 1 m^2 of the first centimeter of concrete depth (K-H 2003). Measurements for surface gamma activity are presented in Tables 15-17. In Survey Units DOP001, DOP002, and DOP003, the activities ranged from 2,400 to 13,000 cpm (0.35 to 2.34 nCi/g), with the highest activity identified in the east and west sumps of DOP003 which measured 6,800 and 13,000 cpm, respectively (Table 17).

COMPARISON OF RESULTS WITH GUIDELINES

Verification survey data results are compared with the DOE-approved site-specific release criteria. Measurements exceeding the guidelines were identified in several survey units throughout the building. Survey units that had measurements exceeding guidelines for the free release of materials are provided in Table 14. The area having the greatest number of locations above the average and maximum release criteria were identified on the ground level in Survey Units 374002 through 374006. Measurements ranged from 0 to 1,900 dpm/100 cm^2 in these survey units with the majority of contamination detected on the floor of survey unit 374002. Forty-two measurement locations in Survey Units 374002 through 374004 and 374006 exceeded the guidelines in which, twenty (40 percent) of these exceeded the maximum of 300 dpm/100 cm^2. However, no removable activity above the guideline was identified. DOE and K-H were notified of the findings.

In two survey units located on the Mezzanine level (374005 and 374008) of Building 374, scans identified two locations for additional investigation. Static measurements were taken and both exceeded the maximum TSA guideline at 300 and 330 dpm/100 cm^2, respectively. No measurable removable activity was identified. DOE and K-H were notified of the findings.

In the north truck bay area (Survey Unit 374011), the IVT identified one location that exceeded the maximum TSA guideline. A five-point measurement in the contiguous square meter area resulted in an average activity of 300 dpm/100 cm^2 that still exceeded the average guideline. No removable activity above the guideline was identified. DOE and K-H were notified of the findings.

TSA measurements were obtained in Survey Units DOP001, DOP002, 374001, 374010, and 374017 (all in Room 2804) were primarily from upper wall and ceiling locations. All DOP TSA measurements were on surfaces that were above the final finish grade of the building which were subject to free release guideline criteria. One location in the DOP001 survey unit and three locations in the DOP002 survey unit exceeded the maximum TSA guideline. The one TSA measurement exceeding the guideline in DOP001 was obtained from a plenum housing. The removable activity (80 dpm/100 cm^2) exceeded the guideline. The three locations identified in the DOP002 were found on a metal beam just below grating from the ground level floor. No removable activity above the guideline was found.

Fifty-eight measurements were collected in Survey Units 374001, 374010, and 374017. These units were subject to the free release guideline criteria for surfaces that were greater than six feet above the final grade. Of the fifty-eight measurements, two exceeded the maximum hot spot guideline criteria of 300 dpm/100 cm^2. The higher of the two was 8,000 dpm/100 cm^2 identified on a metal bracing. This location was also one of only two that had removable activity greater than 20 dpm/100 cm^2. Four TSA measurement locations in Survey Unit 374001 exceeded the average guideline criteria. Two of the measurement locations (11 and 12) were remediated by K-H and the IVT re-evaluated the locations. The post-remediation results included both locations within the same 1 m^2 area and were averaged. The final result met the average guideline criteria.

Gamma surface activity measurements were performed in the DOP survey units to determine if the remaining radionuclide concentration in the building slab would meet the surface criteria of 100 nCi/g. Measurements ranged from 2,400 cpm to 13,000 cpm with a calculated activity of 0.35 to 2.34 nCi/g, well below the concentration guidelines.

FOLLOW-UP ACTIONS AND CONCLUSIONS

DOE and K-H were notified of all locations that exceeded TSA guideline criteria measurements. The survey effort identified numerous locations that did not meet the established guideline criteria for the free release of surfaces above six feet below final grade. The majority of measurement locations that exceeded the release guideline criteria was determined to be on the floor and lower walls in Survey Units 374002 and 374004. In Survey Unit 374001, the highest activity exceeding the release criteria was found on a ledge on the west wall and another hot spot along the north side of the wall. These two locations were immediately decontaminated to acceptable levels by K-H. Five locations were identified in Survey Unit 374003 along the I-beams and horizontal surfaces of the duct work, as well as four from the upper walls in Survey Unit 374001 (Room 2804).

All locations that exceeded either the average or maximum guideline release criteria were discussed and walked-down by DOE and K-H prior to ESSAP demobilizing from the site. Per the direction of DOE, all locations with levels of radioactivity above the release criteria were remediated by either removing the material and equipment or by wiping down the surface. Most of the decontamination of identified locations was conducted after ESSAP had demobilized. Therefore, the K-H post-remediation measurement results were provided to DOE for ESSAP's review (DOE 2005a and b). The results indicated that the total surface activity was reduced to levels less than release guidelines (DOE 2005a). DOE investigated the reported observations and subsequently confirmed that aggressive measures were used to remediate remaining radioactivity above the guideline criteria.

ESSAP reviewed the final results provided by DOE for Building 374 and determined that the remaining alpha activity levels were below the applicable free release guideline criteria. ESSAP determined that all sub-grade slab surfaces greater than six feet below the final grade were well below the 100 nCi/g guideline. Therefore, it is ESSAP's position that the Building 374 Closure Project meets the DOE allowable contamination guidelines.

FIGURES

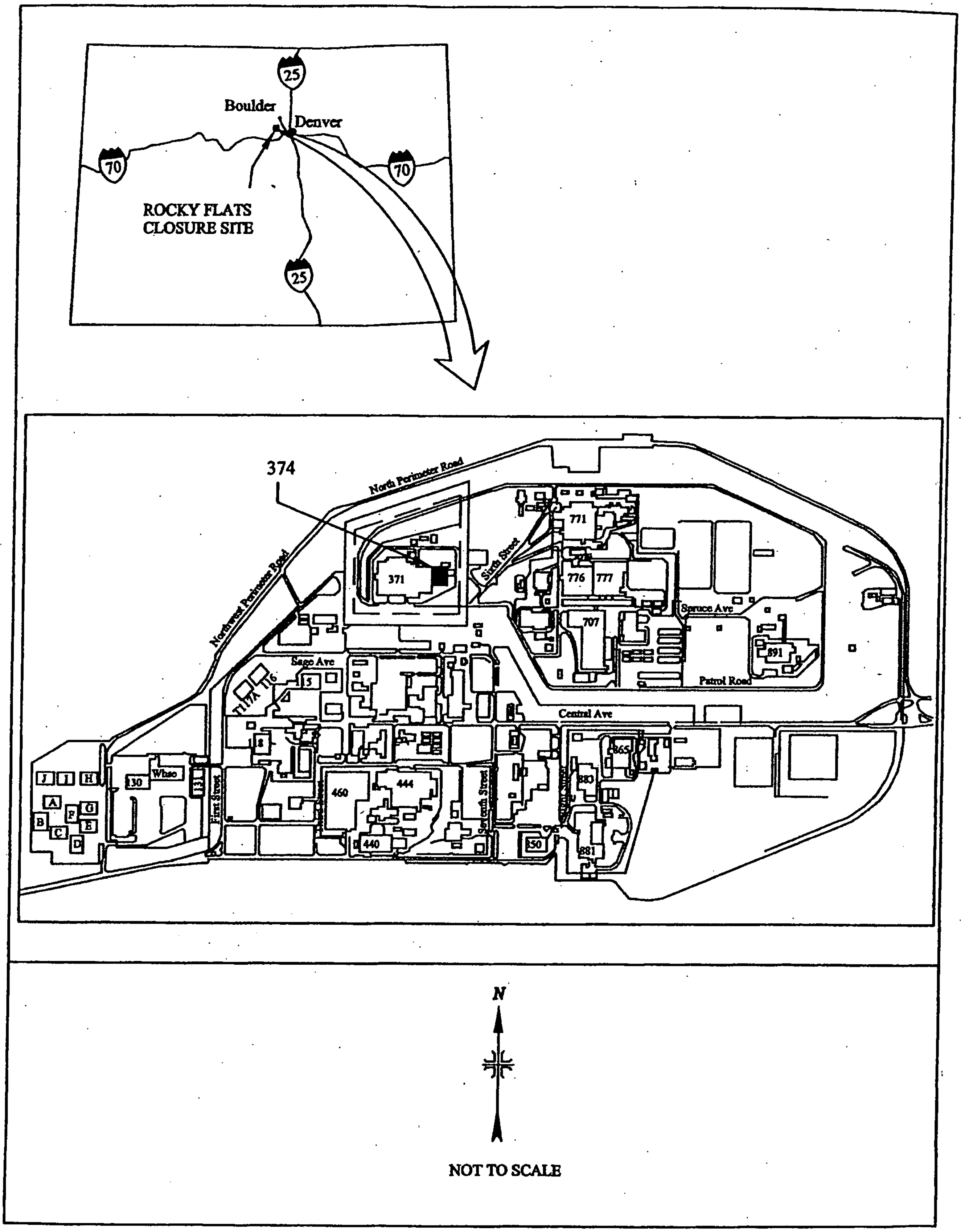


FIGURE 1: Location of the Rocky Flats Closure Site

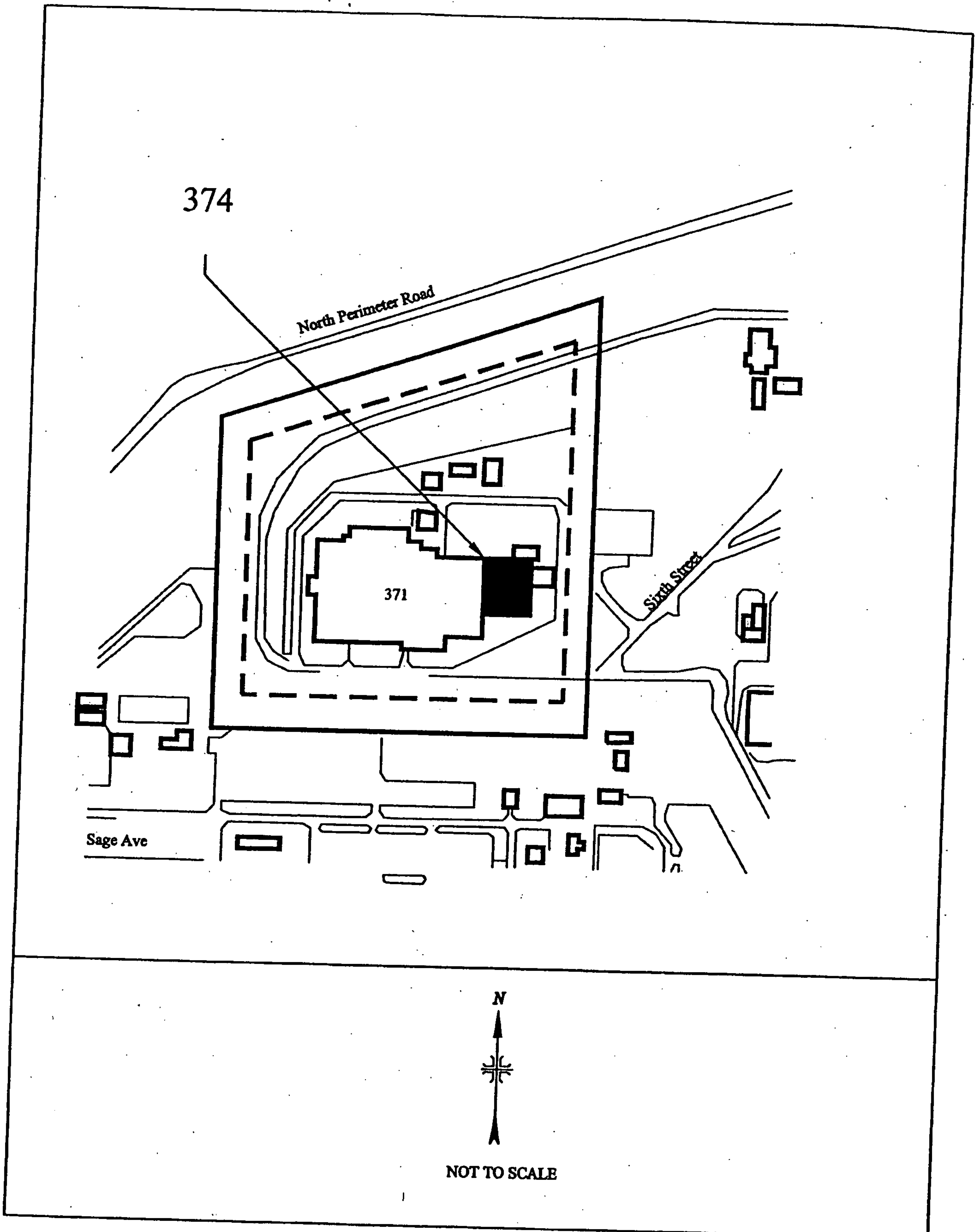


FIGURE 2: Location of the 374 Building

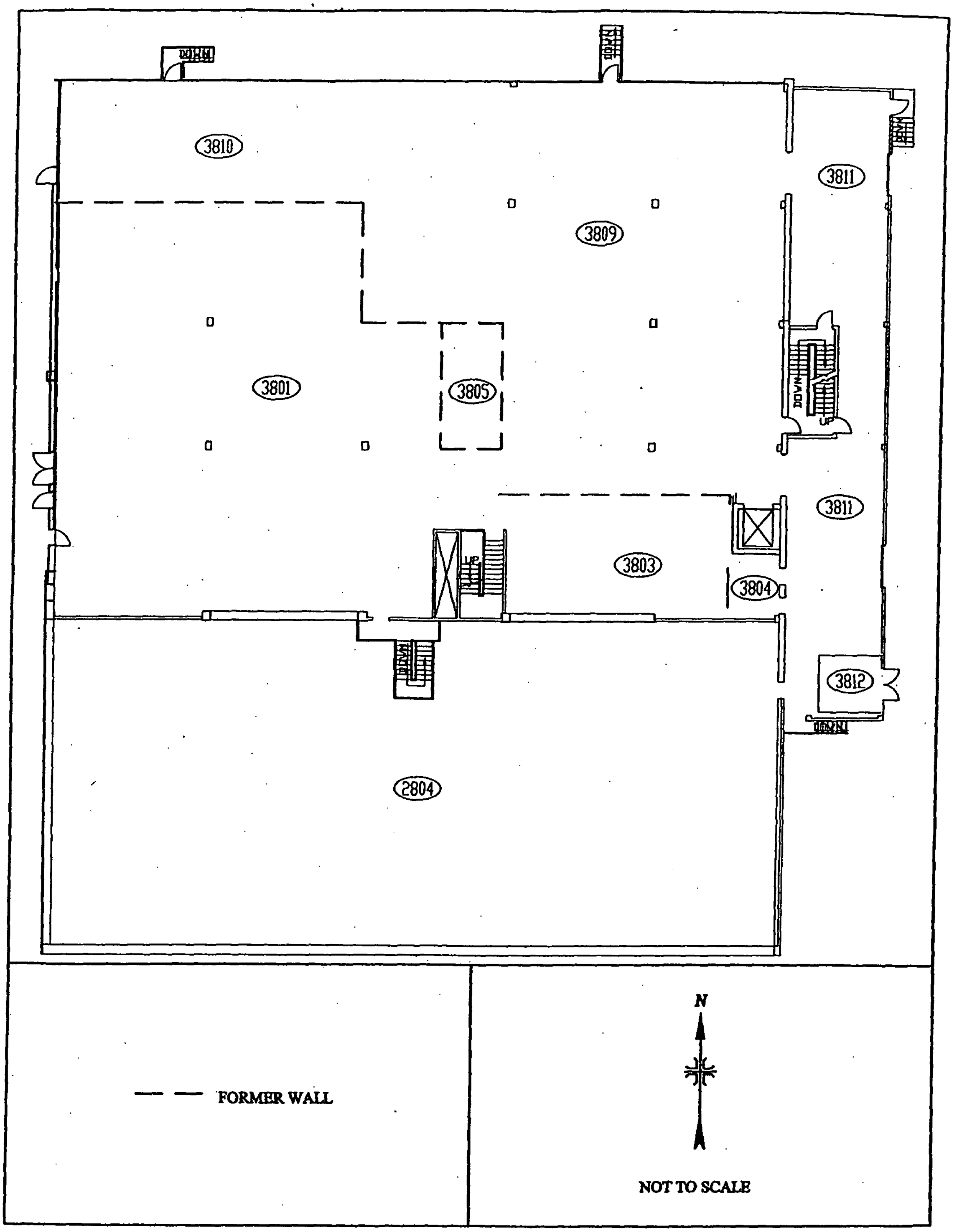
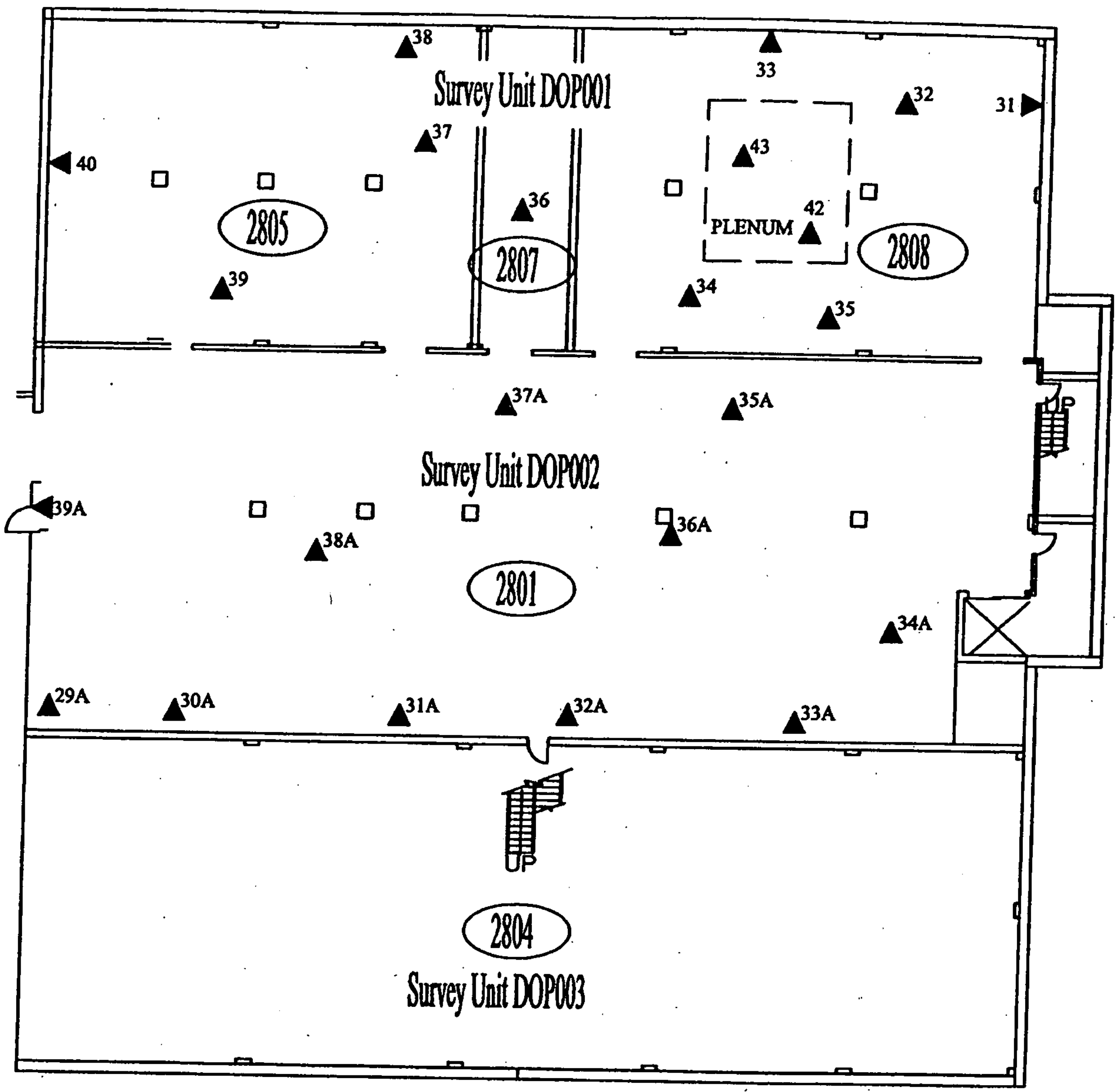


FIGURE 3: Plot Plan of Building 374



MEASUREMENT/SAMPLING LOCATIONS

▲ # SINGLE-POINT UPPER WALLS AND CEILING

NOT TO SCALE

FIGURE 4: DOP Area Upper Walls and Ceiling - Measurement and Sampling Locations

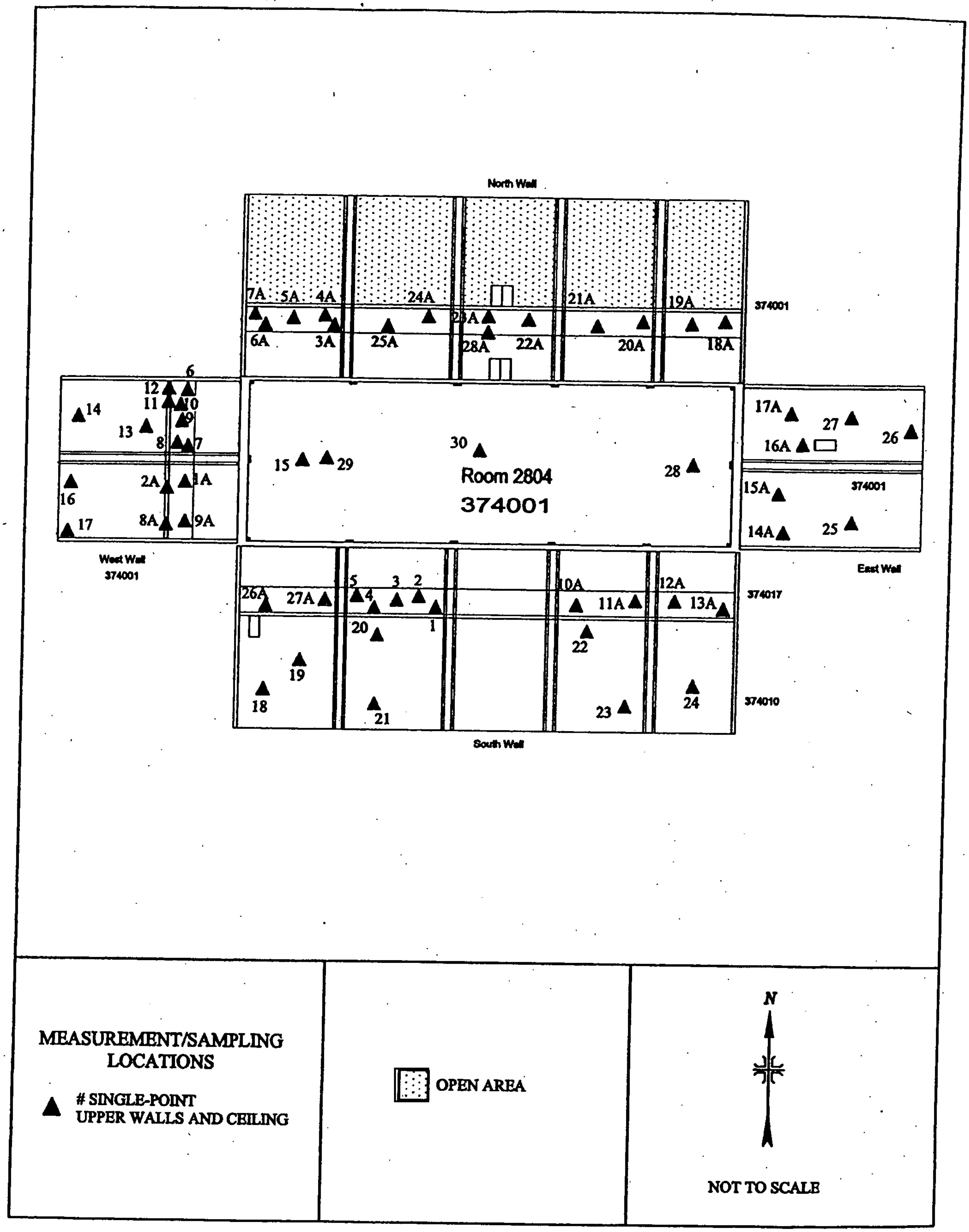


FIGURE 5: Room 2804 - Upper Walls and Ceiling - Measurement and Sampling Locations

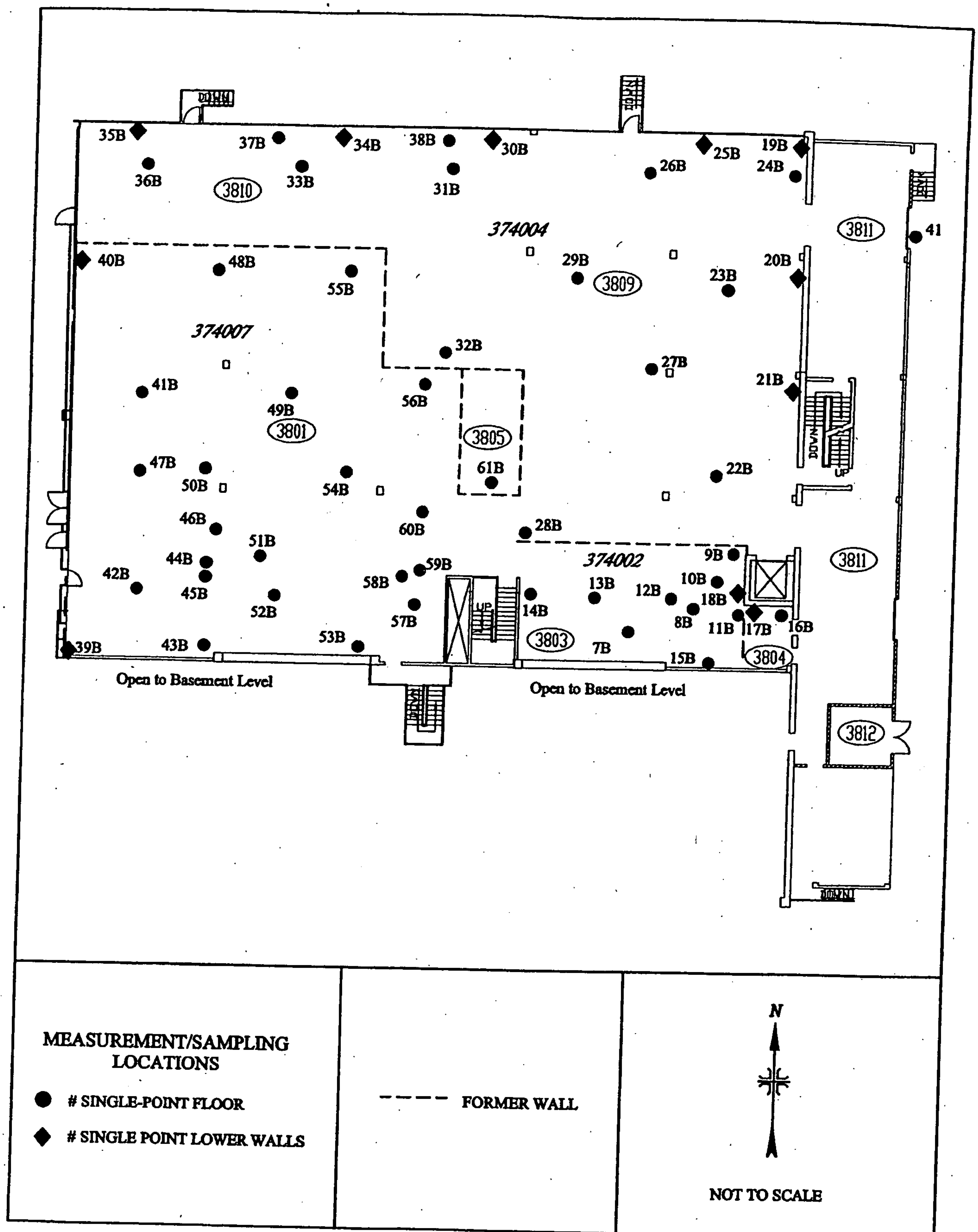
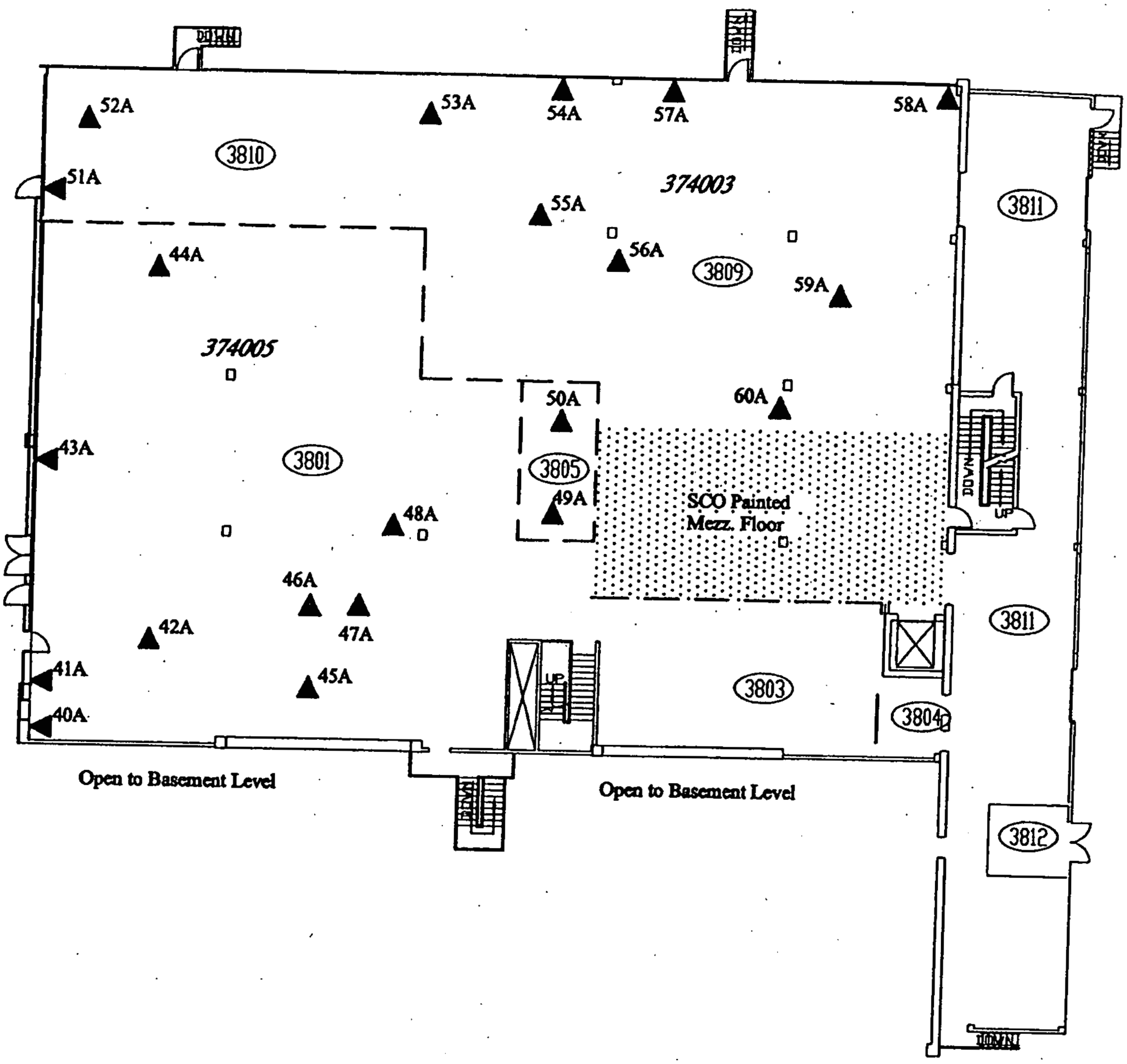


FIGURE 6: Ground Floor Level - Lower Walls and Floor - Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

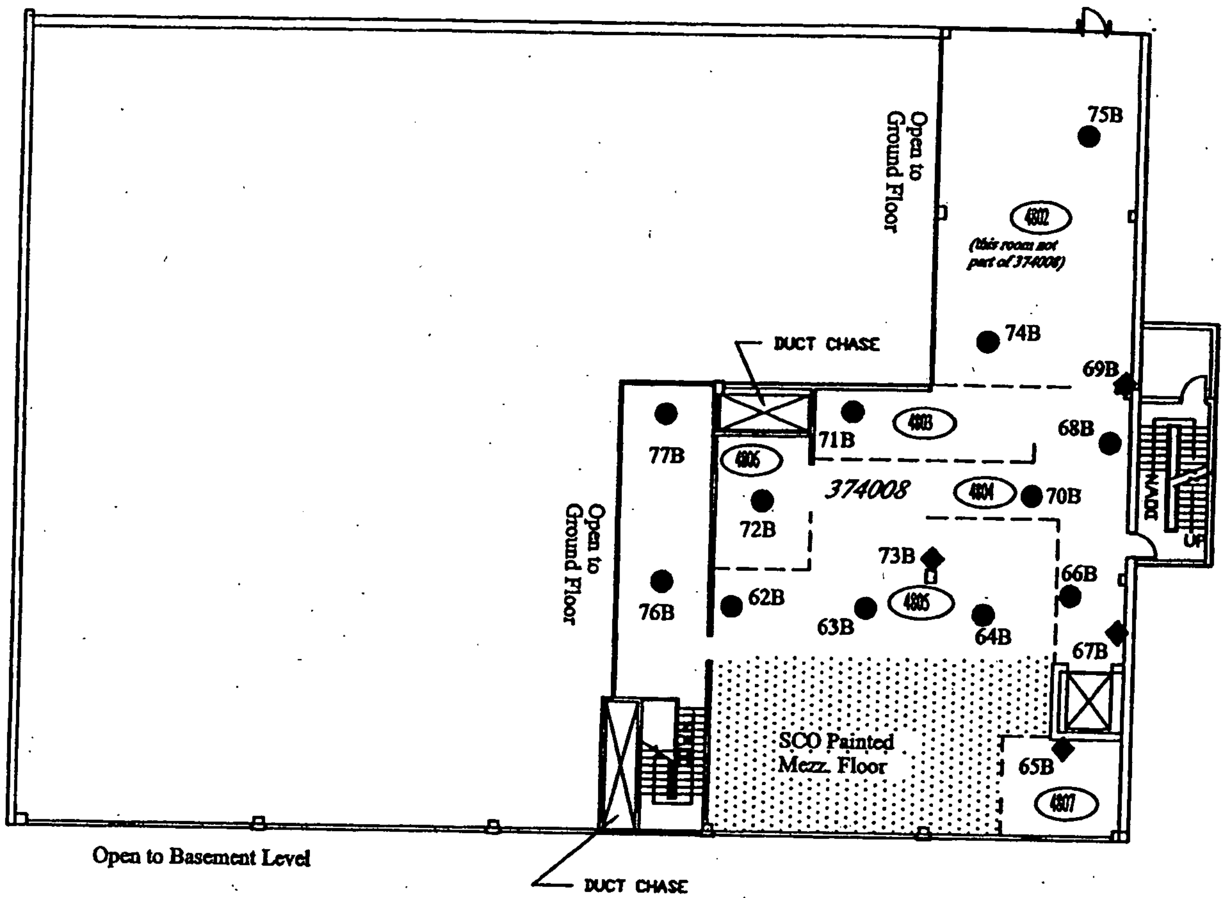
▲ # SINGLE-POINT UPPER WALLS AND CEILING

— — FORMER WALL

N

NOT TO SCALE

FIGURE 7: Ground Floor Level - Upper Walls and Ceiling - Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- ● # SINGLE-POINT FLOOR
- ◆ # SINGLE POINT LOWER WALLS

----- FORMER WALL

N

NOT TO SCALE

FIGURE 8: Mezzanine - Lower Walls and Floor - Measurement and Sampling Locations

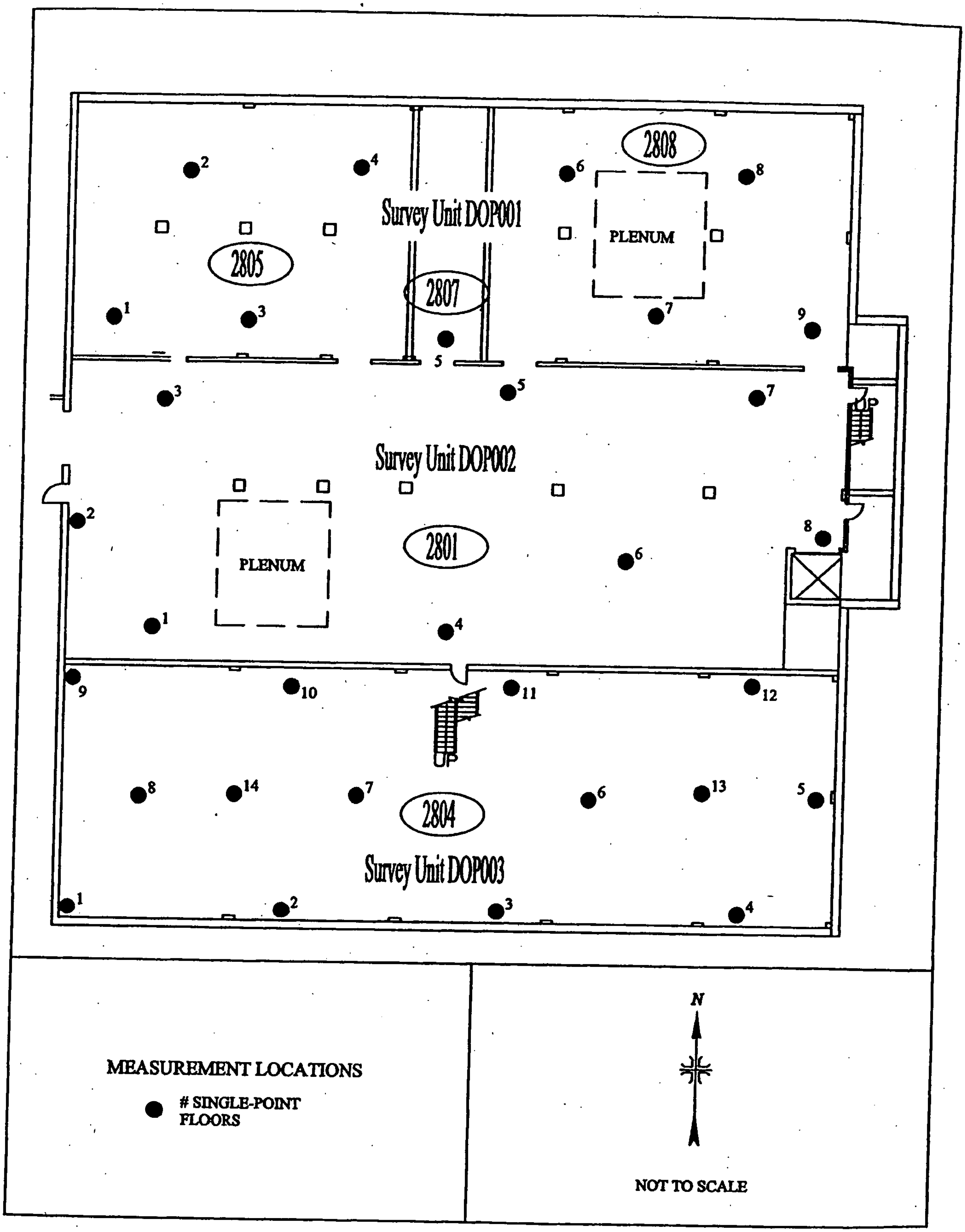


FIGURE 9: Basement Level - Measurement Locations

TABLES

TABLE 1

SURFACE ACTIVITY LEVELS
ROOM 2804 SOUTH WALL
SURVEY UNIT 374017
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
1	16	0
2	160	0
1 m^2 average at loc. 2[c]	46	---[d]
3	24	0
4	24	1
5	40	0

[a]Refer to Figure 5.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required.

TABLE 2

SURFACE ACTIVITY LEVELS
ROOM 2804 NORTH, EAST, AND WEST WALLS
SURVEY UNIT 374001
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
6	87	0
7	56	1
8	24	0
9	32	0
10	40	0
11	370	3
1 m^2 average at loc.11[c]	230	---[d]
12	260	0
1 m^2 average at loc. 12[c]	110	---[d]
1 m^2 average[c and e]	130	---[d]
Post RA Average[c]	110	---[d]
13	40	0
14	48	1
15	16	0
16	32	5
17	16	5
25	56	0
26	24	0
27	32	0
28	24	0
29	16	1
30	8	1
1A	230	0
1 m^2 average at loc. 1A[c]	170	---[d]
2A	40	0

TABLE 2 (Continued)

SURFACE ACTIVITY LEVELS
ROOM 2804 NORTH, EAST, AND WEST WALLS
SURVEY UNIT 374001
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
3A	48	0
4A	71	0
5A	95	0
6A	480	0
7A	8	0
8A	0	0
9A	32	0
14A	29	0
15A	14	0
16A	0	3
17A	14	0
18A	0	0
19A	14	1
20A	7	0
21A	0	1
22A	-7	1
23A	200	3
24A	-7	0
25A	8,000	26
28A	170	3
1 m^2 average at loc. 28A[c]	140	---[d]

[a]Refer to Figure 5.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required.
[e]Average incorporates both locations 11 and 12 due to their close proximity to each other.

TABLE 3

SURFACE ACTIVITY LEVELS
ROOM 2804 UPPER SOUTH WALL
SURVEY UNIT 374010
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
18	16	0
19	32	0
20	40	0
21	32	1
22	16	5
23	79	0
24	8	1
10A	14	0
11A	22	0
12A	-14	1
13A	-7	0
26A	7	3
27A	14	1

[a]Refer to Figure 5.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP"s calibration procedures.

TABLE 4

SURFACE ACTIVITY LEVELS
SURVEY UNIT DOP001
ROOMS 2805, 2801, AND 2808
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
31	16	0
32	0	1
33	100	1
34	8	1
35	32	0
36	16	0
37	48	0
38	16	3
39	32	0
40	79	3
42	370	80
43	16	0

[a]Refer to Figure 4.
[b]Total alpha surface activity measurements were calculated using an alpha efficiency determined in accordance with ESSAP's calibration procedures.

TABLE 5

SURFACE ACTIVITY LEVELS
ROOM 2801—SURVEY UNIT DOP002
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
29A	1,000	5
n/a[c]	1,100[d]	---[e]
30A	380	9
31A	460	7
n/a[c]	72[c]	---[e]
32A	14	0
33A	-7	1
34A	14	1
35A	7	0
36A	29	1
37A	22	5
38A	14	0
39A	7	1

[a]Refer to Figure 4.
[b]Total alpha surface activity measurements were calculated using an alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Measurement location not applicable.
[d]Additional measurement was made to determine if activity was removable or was not spread due to smearing the dirty surfaces.
[e]—Second smear not required.

TABLE 6

SURFACE ACTIVITY LEVELS
SURVEY UNIT 374002
ROOMS 3801 AND 3805
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
39B	72	0
40B	43	0
41B	14	0
42B	1,800	3
43B	22	0
44B	430	0
45B	1,900	0
46B	1,200	0
47B	79	1
48B	65	0
49B	43	1
50B	1,800	3
51B	750	0
52B	170	0
1 m^2 average at loc. 52B[c]	84	---[d]
53B	22	0
54B	79	0
55B	79	1
56B	43	0
57B	1,900	3
58B	1,100	1
59B	570	1
60B	740	0
61B	65	0

[a]Refer to Figure 6.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required.

TABLE 7

SURFACE ACTIVITY LEVELS
SURVEY UNIT 374003
ROOM 3801
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
40A	36	0
41A	0	0
42A	350	1
43A	29	0
44A	220	11
1 m^2 average at loc. 44A[c]	140	---[d]
45A	270	18
1 m^2 average at loc. 45A[c]	230	---[d]
46A	170	7
1 m^2 average at loc. 46A[c]	140	---[d]
47A[e]	270	7
48A	270	7
1 m^2 average at loc. 48A[c]	240	---[d]
49A	220	9
1 m^2 average at loc. 49A[c]	190	---[d]
50A	240	7

[a]Refer to Figure 7.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required.
[e]No average activity calculated. Kaiser Hill representatives committed to clean all upper surfaces on the Ground Floor, Survey Unit 374003.

TABLE 8

SURFACE ACTIVITY LEVELS
SURVEY UNIT 374004
ROOMS 3809 AND 3810
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
19B	270	11
1 m^2 average at loc. 19B[c]	180	---[d]
20B	36	1
21B	14	0
22B	79	3
23B	43	1
24B	36	0
25B	36	3
26B	14	0
27B	22	0
28B	58	1
29B	36	0
30B	29	0
31B	7	0
32B	22	1
33B	7	0
34B	58	1
35B	29	0
36B	-7	1
37B	400	1
38B	510	7

[a]Refer to Figure 4.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required.

TABLE 9

SURFACE ACTIVITY LEVELS
SURVEY UNIT 374005
ROOMS 3809 AND 3810
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
51A	110[c]	1
52A	220[c]	11
53A	22	1
54A	170[c]	5
55A	29	0
56A	65	1
57A	300[c]	5
58A	29	0
59A	14	0
60A	22	0

[a]Refer to Figure 7.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]No average activity calculated. Kaiser Hill representatives committed to clean all upper surfaces on the Ground Floor, Survey Unit 374003.

TABLE 10

SURFACE ACTIVITY LEVELS
ROOM 4802 MEZZANINE
SURVEY UNIT 374005
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
74B	32	0
75B	56	0
76B	40	1
77B	79	1

[a]Refer to Figure 7.
[b]Total alpha surface activity measurements were calculated using an alpha efficiency determined in accordance with ESSAP's calibration procedures.

TABLE 11

SURFACE ACTIVITY LEVELS
SURVEY UNIT 374006
ROOM 3803
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
7B	460	1
8B	710	1
9B	260	1
1 m^2 average at loc. 9B[c]	140[c]	---[d]
10B	310	0
11B	65	1
12B	87	0
13B	79	0
14B	65	1
15B	14	0
16B	14	0
17B	0	1
18B	7	0

[a]Refer to Figure 3.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required.

TABLE 12

SURFACE ACTIVITY LEVELS
MEZZANINE
SURVEY UNIT 374008
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
62B	71	3
63B	32	0
64B	56	0
65B	330	1
1 m^2 average at loc. 65B[c]	83	---[d]
66B	120	0
1 m^2 average at loc. 66B[c]	59	---[d]
67B	8	0
68B	48	0
69B	32	0
70B	48	0
71B	40	0
72B	32	0
73B	330	3

[a]Refer to Figure 5.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required.

TABLE 13

SURFACE ACTIVITY LEVELS
SURVEY UNIT 374011
ROOM 3811
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
41	510	5
1 m^2 average at loc. 41[c]	330	---[d]

[a]Refer to Figure 3.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required.

TABLE 14

SUMMARY OF SURFACE ACTIVITY LEVELS IN EXCESS OF GUIDELINES ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Room	Survey Unit	Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
2801	DOP002	29A	1,000	5
		29A[c]	1,100	---[d]
		30A	380	9
		31A	460	7
		31A[c]	72	---[d]
2808	Plenum	42	370	80
2804 South Wall	374017	2	160	0
		1 m^2 average at loc. 2[c]	46	---[d]
2804	374001	1A	230	0
		1 m^2 average at loc. 1A[c]	170	---[d]
		6A	480	0
		11	370	3
		12	260	0
		1 m^2 average at loc. 11 & 12[c]	130	---[d]
		23A	200	3
		25A	8,000	26
		28A	170	3
		1 m^2 average at loc. 28A[c]	140	---[d]

TABLE 14 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
IN EXCESS OF GUIDELINES
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Room	Survey Unit	Measurement Location[a]	Total Alpha Surface Activity ($dpm/100\ cm^2$)[b]	Total Removable Activity ($dpm/100\ cm^2$)
3805	374002	42B	1,800	3
		44B	430	0
		45B	1,900	0
		46B	1,200	0
		50B	1,800	3
		51B	750	0
		52B	170	0
		1 m^2 average at loc. 52B[c]	84	---[d]
		57B	1,900	3
		58B	1,100	1
		59B	570	1
		42B	1,800	3
		60B	740	0
3801	374003	42A	350	1
		44A	220	11
		1 m^2 average at loc. 44A[c]	140	---[d]
		45A	270	18
		1 m^2 average at loc. 45A[c]	230	---[d]
		46A	170	7
		1 m^2 average at loc. 46A[c]	140	---[d]

TABLE 14 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
IN EXCESS OF GUIDELINES
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Room	Survey Unit	Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
3801 (Continued)	374003 (Continued)	47A	270	7
		48A	270	7
		1 m^2 average at loc. 48A[c]	240	---[d]
3805	374003	49A	220	9
		1 m^2 average at loc. 49A[c]	190	---[d]
		50A	240	7
3809	374004	19B	270	11
		1 m^2 average at loc. 19B[c]	180	---[d]
3810	374004	37B	400	1
		38B	510	7
3810	374005	51A	110	1
		52A	220	11
		54A	170	5
3809	374005	57A	300	5
3803	374006	7B	460	1
		8B	710	1
		9B	260	1
		1 m^2 average at loc. 9B[c]	140	---[d]
		10B	310	0
4807	374008	65B	330	1
		1 m^2 average at loc. 65B[c]	83	---[d]

TABLE 14 (Continued)

SUMMARY OF SURFACE ACTIVITY LEVELS
IN EXCESS OF GUIDELINES
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Room	Survey Unit	Measurement Location[a]	Total Alpha Surface Activity (dpm/100 cm^2)[b]	Total Removable Activity (dpm/100 cm^2)
4801	374008	66B	120	0
		1 m^2 average at loc. 66B[c]	59	---[d]
4805	374008	73B	330	3
3811	374011	41	510	5
		1 m^2 average at loc. 41[c]	330	---[d]

[a]Refer to Figures 4-8.
[b]Total alpha surface activity measurements were calculated based on alpha efficiency determined in accordance with ESSAP's calibration procedures.
[c]Average activity based on five measurement locations within contiguous square meter of flagged elevated result.
[d]--- No smear for removable activity required
[e]Additional measurement was made to determine if activity was removable or was not spread due to smearing the dirty surfaces.

TABLE 15

GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY UNIT DOP001
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	Volumetric Concentration (nCi/g)[b]
1	3,000	0.43
2	2,600	0.38
3	3,200	0.46
4	3,100	0.44
5	2,700	0.39
6	2,400	0.35
7	3,300	0.47
8	3,500	0.50
9	3,700	0.53

[a]Refer to Figure 9.
[b]Calculated based on assumptions in Rocky Flats Calculation Number 05-RS-0002 (K-H 2005b).

TABLE 16

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY UNIT DOP002 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	Volumetric Concentration (nCi/g)[b]
1	3,100	0.45
2	3,600	0.52
3	3,100	0.44
4	3,100	0.45
5	3,100	0.45
6	3,600	0.52
7	3,700	0.53
8	3,500	0.50

[a]Refer to Figure 9.
[b]Calculated based on assumptions in Rocky Flats Calculation Number 05-RS-0002 (K-H 2005b).

TABLE 17

**GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY UNIT DOP003
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO**

Location[a]	FIDLER Result (cpm)	Volumetric Concentration (nCi/g)[b]
1	3,400	0.61
2	3,400	0.61
3	3,500	0.63
4	2,700	0.48
5	3,600	0.64
6	3,300	0.59
7	3,000	0.53
8	3,300	0.60
9	3,300	0.60
10	3,200	0.57
11	3,200	0.58
12	3,400	0.61
13 (Sump #2)	6,800	1.22
14 (Sump #1)	13,000	2.34

[a]Refer to Figure 9.
[b]Calculated based on assumptions in Rocky Flats Calculation Number 05-RS-0002 (K-H 2005b).

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APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Alpha

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Floor Monitor Model 239-1
combined with
Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-37, Physical Area: 550 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Alpha Scintillation Detector Model 43-89 or 43-90, Physical Area: 100 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Gamma

Ludlum Ratemeter-Scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to
BICRON NaI Scintillation Detector
Model G5 FIDLER
(Bicron Corporation, Newburg, OH)

DIRECT MEASUREMENT INSTRUMENT

Low Background Gas Proportional Counter
Model LB-5100-W
(Canberra/Tennelec, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

A walkdown of the project area was performed to evaluate the survey areas for potential health and safety issues that may not have been identified by the site. Additionally, the proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in applicable job hazard analyses (JHAs). The procedures entailed minimal potential hazards that were currently addressed in ESSAP JHAs.

Personnel adhered to the site health and safety requirements. Project training requirements were met prior to entry into the survey areas. General employee radiological training for site access was completed and the IVT completed beryllium worker qualification, including on-site physical, chest x-ray, and classroom lecture. In addition, the IVT received building specific entry and safety requirements. Confirmatory survey activities were conducted in areas that were not downposted for radiation or beryllium contamination and site dosimetric considerations were applicable.

QUALITY ASSURANCE

Calibration

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the ESSAP:

- Survey Procedures Manual (September 2004)
- Laboratory Procedures Manual (August 2004)
- Quality Assurance Manual (August 2004)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1B and the U.S. Nuclear Regulatory Commission

Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Instrumentation had to be re-calibrated once at the site because of the effect of altitude on detection capability.

Detectors used for assessing total surface alpha activity were calibrated in accordance with ISO-7503[1] recommendations. The total efficiency (ε_{total}) was determined for each instrument/detector combination and consisted of the product of the 2π instrument efficiency (ε_i) and surface efficiency (ε_s): $\varepsilon_{total} = \varepsilon_i \times \varepsilon_s$

The alpha calibration efficiency for detectors used for the project, calibrated to Am-241 was typically between 0.10 and 0.11. The alpha calibration source was selected based on the alpha energy distribution of the radionuclide of concern. ISO-7503 recommends an ε_s of 0.25 when measuring alpha emitters. Calibration source emission rates were corrected for geometry when the sources used were smaller than the detector window area.

The gamma calibration efficiency for the FIDLER detector was determined to ISO-7503 recommendations. A NIST traceable Am-241 calibration source (maximum gamma energy of

[1]International Standard. ISO 7503-1, Evaluation of Surface Contamination - Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. August 1, 1988.

59.5 KeV) was used to develop the optimal instrument efficiency using a 4 π source activity. The calculated ε_{total} ranged between 0.08 to 0.11, depending on the detector. The calibration source emission rates were corrected for geometry when a source larger than the detector was used.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detector slowly over the surface. The distance between the detectors and surface was maintained at a minimum, nominally about 1 cm. A large surface area, (600 cm^2) gas proportional floor monitor was used in a qualitatively posture to scan the floors. Other surfaces (walls, ceilings, ledges, etc.) were scanned using a small area 126 cm^2 hand-held gas proportional detector or using a 100 cm^2 alpha scintillator detector. DOP areas were scanned using a low-energy photon FIDLER detector with a probe area 127 cm^2. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument.

Scanning for alpha emitters must be derived differently than scanning for beta and gamma emitters. For the most part, the background response of most alpha detectors is very close to zero, typically registering no more than 2 or 3 cpm. The equation for alpha scan MDC is based on the MARSSIM[3] equation in Appendix J:[2]

The nominal scan rate for alpha scan is determined to range from 2 to 5 cm/s. The probability of detecting one count should be specified as at least 90%, but frequently it will be 95% (i.e., 0.95).

Finally, the use of a 100 cm^2 hot spot size allows the calculation of alpha scan MDC in units of dpm/100 cm^2.

[2]NUREG-1575. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), U.S. Nuclear Regulatory Commission. Washington, DC; June 2000.

In considering an evaluation of the scan MDC for Pu-239 on a concrete slab, a scan speed of 3 cm/s is assumed such that a residence time of 3.33 seconds is maintained over the contamination. Typically, an instrument efficiency is assumed to be 0.44 and the surface efficiency is 0.25 according to ISO-7503. The scan MDC is based on a 90% probability of detecting one count: Using these parameters this equation yields a scan MDC of 380 dpm/areas depicted as follows:

$$\alpha\ scan\ MDC = \frac{[-\ln(1-0.9)]60}{(0.44)(0.25)(3.33)} = 380\ dpm/100\ cm^2$$

For backgrounds greater than zero, e.g., 1 to 3 cpm, the calculational approach and scan MDC result are still valid, however, it is at the expense of an increased false positive rate. That is, the surveyor will be more likely to mistake background as contamination. For background count rate on the order of 5 to 10 cpm, a single count should not cause a surveyor to investigate further, primarily because there would be an inordinate amount of false positives.

Specific scan MDCs for the NaI scintillation detector for the radionuclide mixture in concrete were not determined as the instrument was used solely as a qualitative means to identify elevated gamma activity however, MDCs for radionuclides in the concrete would approximate those contained in NUREG-1507.

Surface Activity Measurements

Measurements for total surface activity levels were primarily performed using gas proportional detectors with portable ratemeter-scalers. Surface activity measurements were performed on upper room surfaces, some equipment, and at locations of elevated direct radiation.

Gamma surface activity measurements were performed using the FIDLER detector. A Microshield ™ program calculation was performed based upon calibration variables and detector attributes to determine a field action level. The result calculated a field action level of 250,000 cpm that was used to conduct additional investigation.

Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the total efficiency ($\varepsilon_i \times \varepsilon_s$) and correcting for the active area of the detector.

Gamma count rates were integrated over one minute using the FIDLER. Count rates (cpm) were converted to nanocuries per gram (nCi/g) using the following equation:

$$\left(\frac{cpm}{\varepsilon_T * \varepsilon_p * 127cm^2}\right)*\left(\frac{127\ cm^2}{W}\right)*\left(\frac{nCi}{2220dpm}\right)*8\frac{Pu}{Am}$$

where:

ε_T = Total Efficiency = 0.08
ε_p = Attenuation Correction Factor for Painted Surfaces = 0.679

W = Volume * Density of Concrete = $127cm^2$ * 1 cm * 2.35 g/cm^3 = 298.45 g

Note: Volume is calculated as physical detector area x DCGL depth

8 = ratio of Pu-239 to Am-241 for 35-year old WGP

Removable Activity Measurements

Removable gross alpha levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

ANALYTICAL PROCEDURES

Gross Alpha

Smears were counted for two minutes on a low-background gas proportional system for gross alpha activity. The typical MDC of the procedure was 9 dpm/100 cm^2 for gross alpha activity.

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 3 plus 4.65 times the standard deviation of the background count $[3 + (4.65 \sqrt{BKG})]$. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5 (DOE 1990)

BASIC DOSE LIMITS

The basic dose limit for the annual radiation (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

EXTERNAL GAMMA RADIATION

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate land-use scenario is considered.

SURFACE CONTAMINATION GUIDELINES

Allowable Total Residual Surface Contamination
(dpm/100 cm^2)[a]

Radionuclides[b]	Average[c,d]	Maximum[d,e]	Removable[d,f]
Transuranics, Ra_226, Ra_228, Th_230 Th_228, Pa_231, Ac_227, I_125, I_129	100	300	20
Th_Natural, Th_232, Sr_90, Ra_223, Ra_224, U_232, I_126, I_131, I_133	1,000	3,000	200
U_Natural, U_235, U_238, and associated decay products	5,000	15,000	1,000
Beta_gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr_90 and others noted above	5,000	15,000	1,000

[a]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b]Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[c]Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d]The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

[e]The maximum contamination level applies to an area of not more than 100 cm^2.

[f]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

November 30, 2005

Mr. Ron Bostic
Rocky Flats Project Office
U.S. Department of Energy
10808 Hwy 93, Unit A
Golden, CO 80403

**SUBJECT: DOE CONTRACT NO. DE-AC05-00OR22750
FINAL REPORT-FINAL STATUS VERIFICATION SURVEY REPORT OF THE FORMER BUILDING 707, ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN, COLORADO**

Dear Mr. Bostic:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) conducted Final Status Verification Survey Report of the Former Building 707, Rocky Flats Environmental Technology Site in Golden, Colorado. Comments provided on the draft report have been incorporated into the final report.

Please contact me at (865) 576-5321 or Scott Kirk at (865) 574-0685 should you need additional information.

Phyllis Weaver
Health Physics/Project Leader
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Enclosure

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The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. ORISE is managed by Oak Ridge Associated Universities. Established in 1946, ORAU is a consortium of 91 colleges and universities.

NOTICES

VERIFICATION SURVEY REPORT
OF THE
FORMER BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Prepared by

P. C. Weaver

Environmental Survey and Site Assessment Program
Radiological Safety, Assessments and Training
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for the

Department of Energy

FINAL REPORT

NOVEMBER 2005

This report is based on work performed under contract number DE-AC05-00OR22750 with the U.S. Department of Energy.

VERIFICATION SURVEY REPORT
OF THE
FORMER BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN COLORADO

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ABBREVIATIONS AND ACRONYMS

AST	above-ground storage tanks
BSI	Bartlett Services Incorporated
CDPHE	Colorado Department of Public Health & Environment
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DCGL	derived concentration guideline level
DOE	Department of Energy
DOP	decommissioning operations plan
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQO	data quality objectives
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
ITP	Intercomparison Testing Program
IV	independent verification
IVPP	independent verification project plan
IVT	independent verification team
JHA	job hazard analysis
K-H	Kaiser-Hill Company
m	meter
m^2	square meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
mm	millimeter
MeV	million electron volts
mrem/yr	millirem per year
NEPA	National Environmental Policy Act
NIST	National Institute of Science and Technology
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
PDS	pre-demolition survey
PDSR	pre-demolition survey report
PRA	post-remedial action
RFETS	Rocky Flats Environmental Technology Site
RFPO	Rocky Flats Project Office

VERIFICATION SURVEY REPORT
OF THE
FORMER BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

INTRODUCTION AND SITE HISTORY

The Atomic Energy Commission, predecessor agency to the U.S. Department of Energy (DOE), selected the Rocky Flats site in 1951 to serve as a nuclear weapons component production facility. Production began in 1952 on both nuclear and non-nuclear components with the plutonium pits being the key component. Uranium and beryllium were also utilized in the production of various components and processes. Operations continued until 1989 when environmental and safety concerns temporarily halted operations. There were over 700 structures, such as process and support buildings that were involved in the site's mission. In 1993, the production mission was permanently ended and a new mission to clean up the site by 2006 was initiated. The site has since been renamed as the Rocky Flats Environmental Technology Site (RFETS).

Kaiser-Hill Company, L.L.C. (K-H), is the DOE contractor responsible for closure of the RFETS by the year 2006. To meet the closure goal, K-H plans to characterize, remediate, perform pre-demolition surveys (PDS) and then demolish each building at the site. Decontamination for the purpose of demolition and disposal has been completed by K-H for Building 707.

Facilities associated with Building 707 were constructed in the early 1970's to house the manufacturing processes formerly performed in Building 776/777. These processes involved the casting, forming, metallurgy, and machining of plutonium metal feed and the assembly and non-destructive testing of the finished weapons components. Plutonium components were then joined with parts constructed from uranium, beryllium, or stainless steel into subassemblies which were then joined into final assemblies. These operations continued until production was suspended in 1989, and the subsequent discontinuation of operations in 1991, when activities in Building 707 and associated facilities were redirected to the new mission of site closure (K-H 2002a).

Decontamination, followed by demolition and waste disposal, has been completed by K-H for Building 707. The decommissioning activities included removal of components and equipment followed by decontamination of the structure and performance of pre-demolition surveys. Building 707 was designated as a Type 3 facility and Buildings 708, 709, 718, 731, 732, 778 and one of the above ground storage tanks (ASTs) were designated as Type 2 facilities in accordance with the RFETS decommissioning program plan (K-H 1999).

The DOE's Rocky Flats Project Office (RFPO) requested that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) provide independent verification (IV) of the final radiological status of the Former Building 707.

SITE DESCRIPTION

The RFETS is located approximately 16 miles northwest of Denver, Colorado on State Highway 93 and Cactus Road. RFETS occupies approximately 385 acres within the 6,000 acre DOE reservation site. During operations at the site there were approximately 700 buildings and structures (Figure 1). Most of the structures were associated with the production of nuclear weapons. The site was divided into two major operable units, the DOE Retained Area and the Site Refuge Area. All nuclear facilities at the site are within the boundaries of the Industrial Area (ORISE 2004a).

The Building 707 facilities were located within the Protected Area of the RFETS. The Building 707 complex facilities included 10 support facilities and 21 ASTs (K-H 2002a) (Figure 2). Building 707 consisted of two-stories with a basement. A one-story addition was located on the east side of the main structure. The plot plans in Figures 3 and 4 provide an overall layout of the first and second floors in the building. The interior first floor consisted of separate modules for the various production activities. The second floor housed the ventilation fans, filter plenums, pumps, and tanks that supported operations. The basement contained various spent solvent and machine oil tanks. Building 778 was a metal Butler building that provided access to Building 707 from Building 776. This structure was significant because it contained a portion of the chainveyor system utilized in Building 707 to transport materials to various production areas (K-H 2002a).

INDEPENDENT VERIFICATION OBJECTIVES

The objectives of the Building 707 independent verification surveys were to confirm that remedial actions were effective in meeting the applicable unrestricted release criteria and that K-H documentation accurately and adequately described the final radiological conditions of the associated areas. The IVT utilized the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guiding principles to conduct verification activities to expeditiously assess the D&D contractors' process.

For the most part, the IVT performed final status surveys in over 90 percent of the survey units selected. However, the IVT implemented an in-process inspection that evaluated the potential outcome of the survey based on the review of significant documentation and procedure implementation for areas not physically evaluated. This included reviewing the methodology used to: (1) classify areas according to contamination potential; (2) procedures for the selection, calibration, and use of survey instrumentation; and (3) adequacy of survey and analytical planning and procedures. Review activities were also focused on procedures that the IVT had not evaluated during verifications of other RFETS closure projects (ORISE 2004a).

DOCUMENT REVIEW

The IVT performed document reviews and provided comments, as appropriate, on the D&D contractor's Decommissioning Operations Plan and Pre-Demolition Survey Plans as part of the independent verification process (K-H 2002a and b). The initial Pre-Demolition Survey Reports (PDSRs) for the Building 707 were reviewed for implementation of the sampling and measurement process and to assess the data quality objectives for the final results of the remediation effort. Follow-up data were reviewed and evaluated to assure that survey units with locations identified by the IVT which exceeded the guidelines were addressed through remediation or properly dispositioned (Appendix D). The final 707 PDSRs for both the first and second floor were reviewed by the IVT (K-H 2004a and b). The report indicates that a significant effort by K-H to remediate or identify components that will be removed during demolition has resulted in a final structure that will meet the established criteria prior to demolition.

SURVEY PROCEDURES

K-H subdivided the 707 facility into 146 survey units—87 Class 1, 34 Class 2, and 25 Class 3. The IVT selected approximately 30 percent of the Class 1 and Class 2 survey units for Type B verification in Building 707. The IVT conducted verification survey activities in accordance with the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2004b and 2004c).

REFERENCE GRID

The IVT utilized the survey unit reference system established by the D&D contractor to identify measurement and sampling locations. Measurement and sampling locations were documented on detailed survey maps.

SURFACE SCANS

ESSAP selected 46 survey units, approximately 30 percent of the total survey units, for verification (Figures 5 to 22). The selected survey units included thirty-one Class 1, fourteen Class 2 survey units, and one Class 3. Alpha surface scan coverage for selected Class 1 survey units covered 100 percent of accessible first floor (floor) survey units, approximately 50 to 70 percent of the second floor (floor) survey units, and approximately 20 to 40 percent for lower walls. Scans on selected Class 2 and 3 survey units ranged from 20 to 50 percent on floors, 10 percent on lower walls, approximately 5 percent of overhead and upper wall surfaces, and approximately 50 percent of former air handling units' exterior and interior surfaces. Overhead and upper surface scans focused on areas such as ledges, support beams, and around penetrations or other openings through the ceiling. Surface scans were performed using instrumentation based on the best available technology and the type of contamination. Standard survey instruments included gas proportional detectors and dual phosphor detectors. Detectors used for scanning were coupled to ratemeter-scalers with audible indicators. Locations having activity measurements greater than field action levels were identified and marked for further investigation.

Surface Activity Measurements

The IVT performed direct measurements for total alpha surface activity at 495 locations in the selected survey units. These survey units include first floor modules "A" through "J", "K", second floor survey area annex "C". In the first floor module "C", direct comparison measurements at locations identified by the D&D contractor were obtained and evaluated. Surface activity measurements were obtained using gas proportional detectors and dual phosphor detectors coupled to ratemeter-scalers. A smear sample for determining removable gross alpha activity was collected at each direct measurement location.

Material specific background measurements for poured concrete (as percent of the building surface) were collected for correcting gross activity measurements performed on structural surfaces.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Radiological samples and data were returned to the ORISE/ESSAP laboratory in Oak Ridge, Tennessee, for analysis and interpretation. Radiological sample analyses were performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 2004d). Smear samples were analyzed for gross alpha and gross beta activity using a low-background gas proportional counter. Smear sample and direct measurement data were converted into units of dpm/100 cm^2. Radiological data were compared to the D&D contractor's results and the established unrestricted release criteria for Building 707.

FINDINGS AND RESULTS

Document Review

The review of the project-generated final data and Pre-Demolition Survey Reports, including the Quality Assurance Scan Surveys document (Appendix D) did not indicate the presence of any residual contamination exceeding the guidelines, other than the identified areas which were marked to be removed as radiological waste during demolition (DOE 2004).

Surface Scans

Alpha surface scans were performed in all 46 survey units on the floors, lower walls, overhead, and upper walls. Alpha scan activity ranged from 0 to 6,000 cpm. The highest alpha levels were identified on the "J" module floor and "K" module walls. ESSAP did not collect measurements in this area of "K" module; rather K-H was notified of ESSAP's findings so that additional remediation could be conducted.

K-H provided post-remediation data for review. The results indicated that the majority of activity on the wall was less than 300 dpm/100 cm^2; however, activity remained at certain locations which exceeded the maximum guideline. However, these areas were covered and subsequently removed during demolition (K-H 2004a).

Surface Activity Measurements

Total surface activity and removable activity measurements quantified the elevated areas of activity identified during scanning (Table 1). Prior to additional remediation, total alpha surface activity ranged from -36 to 31,000 dpm/100 cm^2. Areas with the highest total activity measurements were detected in module "A" survey unit 707027, module "B" survey unit 707035, and module "J" survey unit 707095. Removable alpha activity ranged from 0 to 470 dpm/100 cm^2 with the highest removable activity identified in modules "A" survey unit 707024, "B" survey unit 707035, and "J" survey unit 707095.

Seventy-four verification surface activity measurements from 27 survey units exceeded the 300 dpm/100 cm^2 maximum guideline. Of these 27 survey units, 11 were Class 2. K-H was notified of these results and elected to remediate most areas identified. Areas not remediated were marked and appropriately sealed for subsequent disposal of radiological waste during demolition. Table 2 reports the post-remedial action (PRA) alpha measurements collected by ESSAP. The PRA total alpha activity ranged from 14 to 420 dpm/100 cm^2. Surface activity levels in individual units are reported in Tables 3 to 48.

ESSAP was unable to re-evaluate several remediated locations prior to departure from the site. For a large area of contamination in module "K" identified by ESSAP, K-H remediated the area and provided PRA results to ESSAP for review. The results indicated that the alpha activity levels for the majority of building surfaces were below the maximum allowable guideline. However, there were areas that remained along the floor wall interface in module "K" where the activity exceeded the guideline (Table 2). There were locations in modules "B" and "J" that exceeded the guidelines that K-H had attempted to remediate. However, remediation efforts at these locations were unsuccessful. For these instances, K-H covered these areas with metal plating prior to demolition of the building and floor slab. During demolition, material from this area was disposed of as radiological waste. K-H also designated the floor in survey module "C" for disposal as radiological waste.

COMPARISON OF RESULTS WITH GUIDELINES

Survey results were compared to the following DOE Order 5400.5 surface activity guidelines (DOE 1993 and 1995). The guidelines were used as the site DCGL, which has allowances for 1 m^2 average activity and single hot spot criteria of three times the average guidelines in a 100 cm^2 area. The applicable surface guidelines for transuranics are:

<u>Total Surface Activity</u>

100 α dpm/100 cm^2
300 α dpm/100 cm^2

<u>Removable Surface Activity</u>

20 α dpm/100 cm^2

As part of the verification, three survey units in module "C" were selected by ESSAP to conduct instrument comparison for alpha surface activity with K-H. These comparison measurements were used to verify calibration and instrument operations. These locations were selected during the characterization investigation. The results of the comparison effort are reported in Table 49. ESSAP total alpha activity measurements ranged from 100 to 57,000 dpm/100 cm^2. A review of the ESSAP to K-H data shows that ESSAP's reported activity levels were generally twice those reported by K-H. This difference is attributed to the difference in calibration procedures (i.e., 2 π vs. 4 π detector geometry). ESSAP calculates instrument efficiencies in accordance with ISO-7503 to account for expected attenuation of alpha radiation in the field by applying a correction factor. ESSAP also noted, that in most cases the K-H floor monitor data were 20 to 40 percent less than the K-H reported results.

INTERIM FINDINGS AND RECOMMENDATIONS

ESSAP identified alpha activity exceeding the 300 dpm/100 cm^2 average guideline in 59 percent of the survey units selected for verification. Much of the contamination identified was found in areas not previously identified by K-H as exceptions. ESSAP notified K-H of the findings and they immediately addressed most through remediation or by designating a location as an exception to be addressed during demolition. ESSAP re-evaluated most of the areas and found remediation to be successful. However, a number of locations remained that exceeded the DOE maximum total activity guidelines.

During the interim period, many areas identified during independent verification as having residual contamination would be appropriately addressed by K-H through either decontamination to less than the applicable surface contamination limits or by appropriately disposing material as radioactive waste. However, two issues were identified by ESSAP that called into question the final radiological status of Building 707.

ESSAP identified undocumented contamination in most of the verified survey units. ESSAP initially concluded that undocumented contamination in excess of the guidelines would likely exist in unverified building areas. Secondly, because contamination was identified in excess of the maximum guideline in Class 2 areas, ESSAP questioned whether Class 2 survey units were appropriately classified.

In an effort to determine factors contributing to these findings, ESSAP conducted an instrument comparison study using instrument statistics and calibration data, and previous survey data by K-H. The data presented in Table 49 indicates a partial root cause for the discrepancies identified during verification surveys. Differences were observed between ESSAP and K-H comparison measurements that could not be attributed to the difference in measurement methods but likely due to survey technique.

Therefore, ESSAP recommended that K-H re-evaluate the bases used for survey unit classification and that they consider reclassification and resurvey affected survey units, as necessary. Quality assurance surveys that consisted of surface scans using a graded approach, were recommended for building areas that ESSAP was not able to perform independent verification. These quality assurance surveys performed by K-H were a necessary requirement to provide assurance that remaining areas of residual activity exceeding the maximum allowable guideline would be identified and addressed.

FOLLOW-UP ACTIONS AND CONCLUSIONS

Based on the interim findings and recommendations by ORISE, K-H elected to perform additional quality assurance scans in Building 707. A written survey protocol was developed and reviewed by DOE/RFPO, CDPHE, and ORISE representatives that required additional surveys in five survey units. The five survey units consisted of three Class 1 survey units (which were not verified by ORISE), and two Class 2 survey units (that were verified by ORISE). The units were selected based on a higher potential for contamination due to Building 707 process history. A copy of the survey protocol and associated findings is provided in Appendix D. In summary, a predetermined percentage of each survey unit was scanned to identify areas of elevated activity that may have been missed during the initial scans. The scan frequency was increased until no additional areas of elevated activity were identified.

No additional areas of elevated activity were identified during follow-up scans in three of the five selected survey units (including the two Class 2 survey units selected). One spot of elevated activity was identified in each of the remaining two survey units. Therefore, the scan frequency was increased. No other areas of elevated activity were identified during the additional scans. K-H's quality assurance scans provided additional assurance that areas identified during ESSAP's evaluation had met the release criteria prior to demolition for most building surfaces. It was ESSAP's understanding that areas which were identified as exceptions (unable to remediate for unrestricted release) would be disposed of as radiological waste. These areas were appropriately marked and protected with physical coverings until the surfaces could be dispositioned.

It is ESSAP's position that the Building 707 Closure Project meets the specified unrestricted release limits, with the exception of those areas marked for disposal as radioactive waste.

FIGURES

408-022 (x)

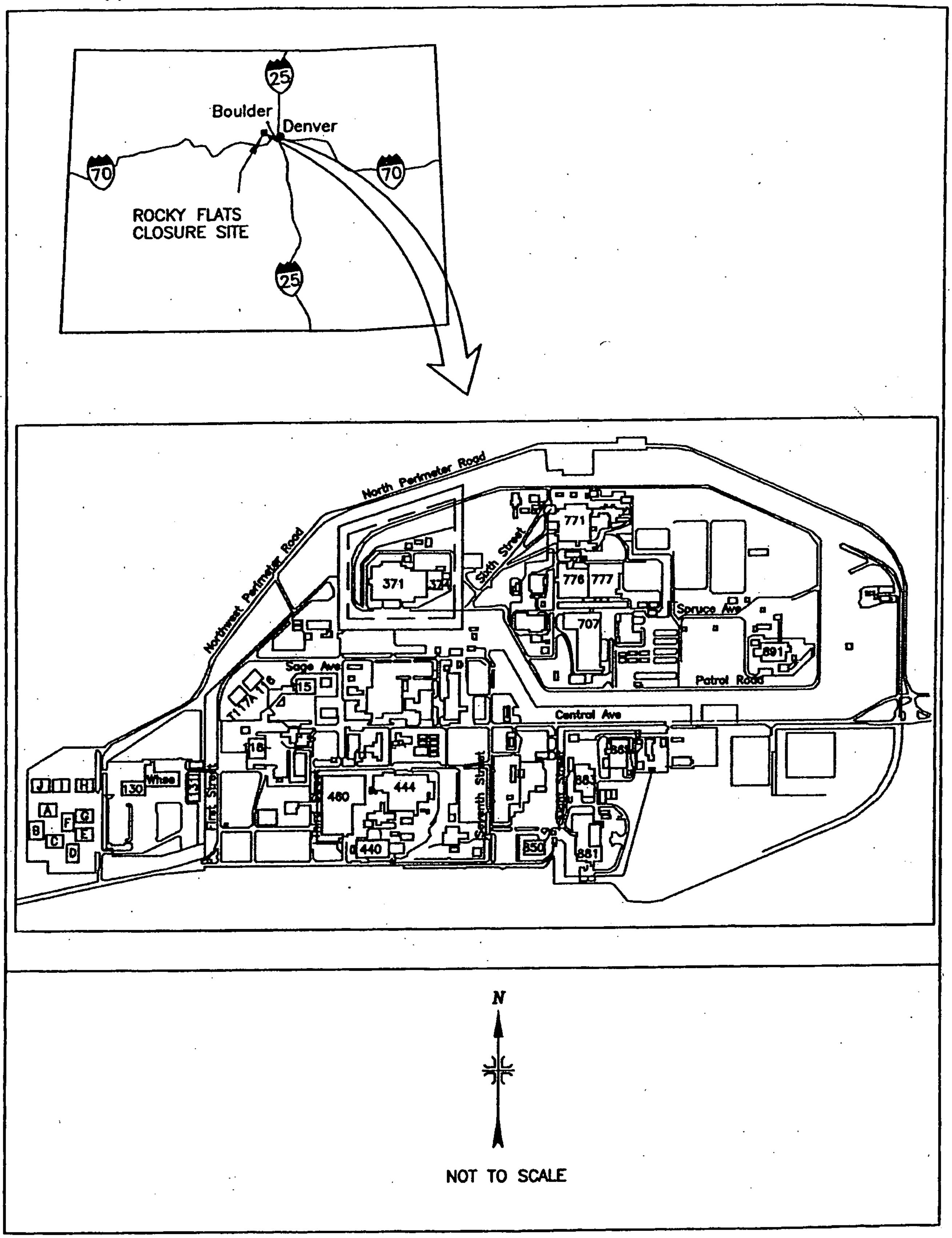


FIGURE 1: Location of the Rocky Flats Closure Site

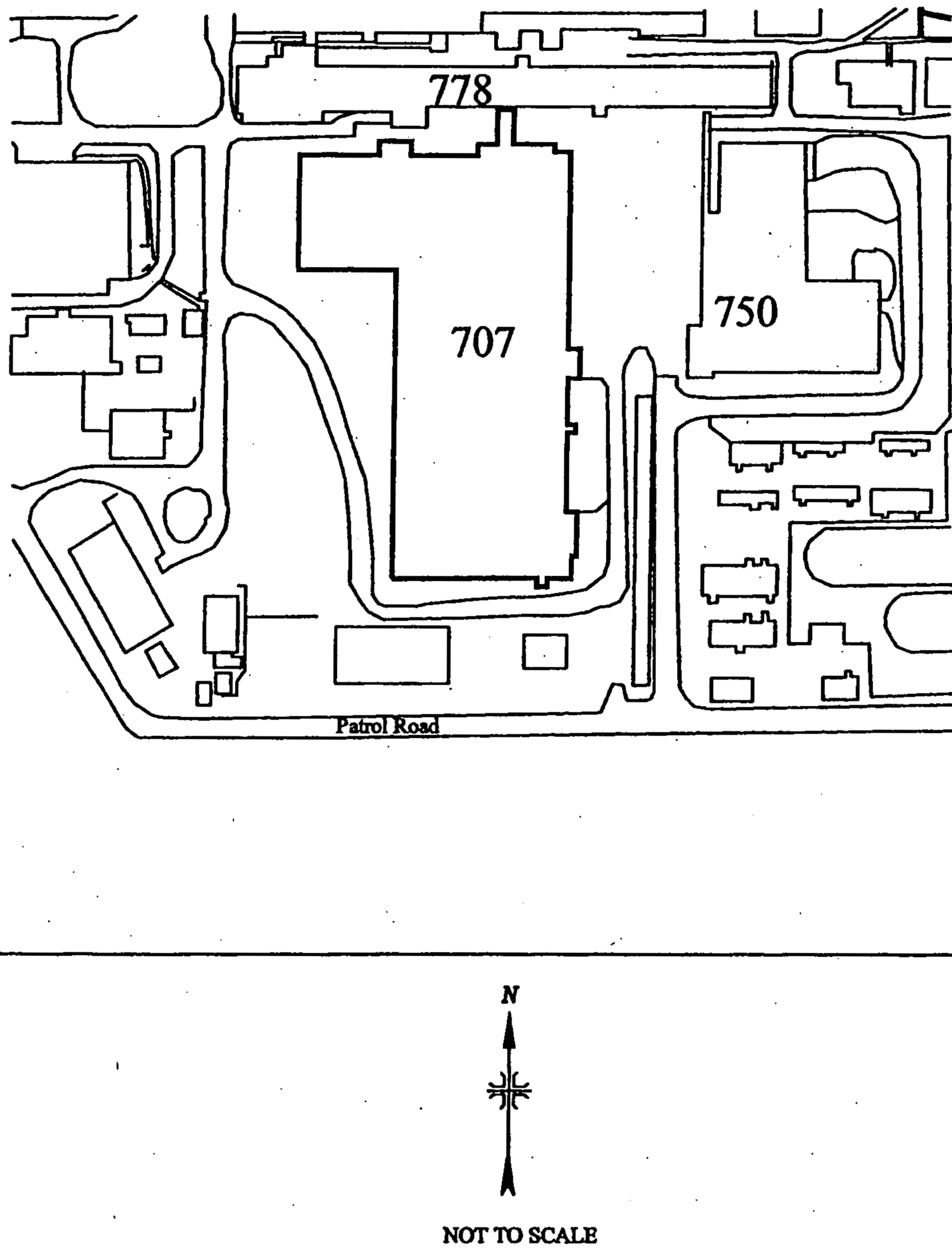


FIGURE 2: Location of the 707 Building

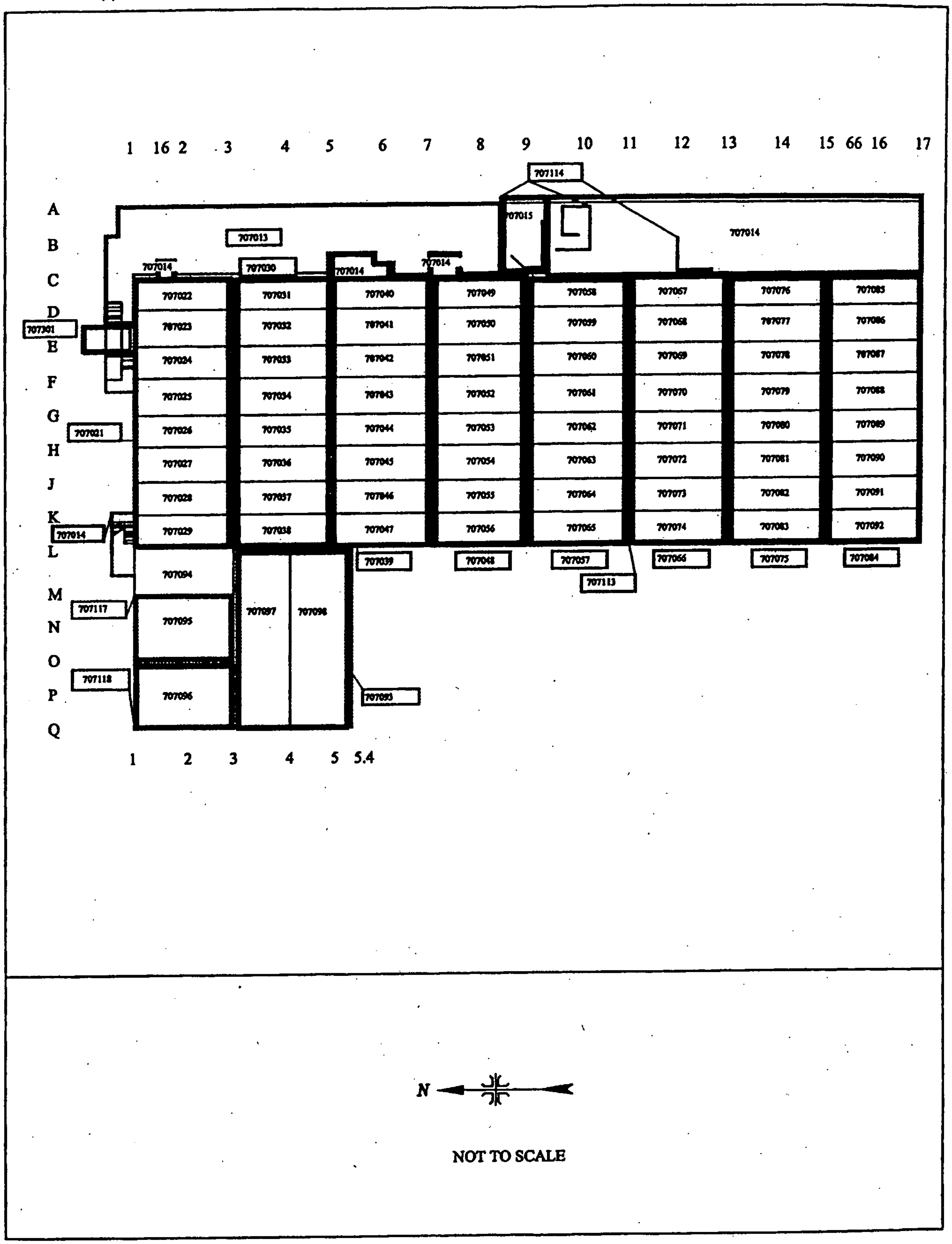


FIGURE 3: Plot Plan of the First Floor Building 707 Survey Units

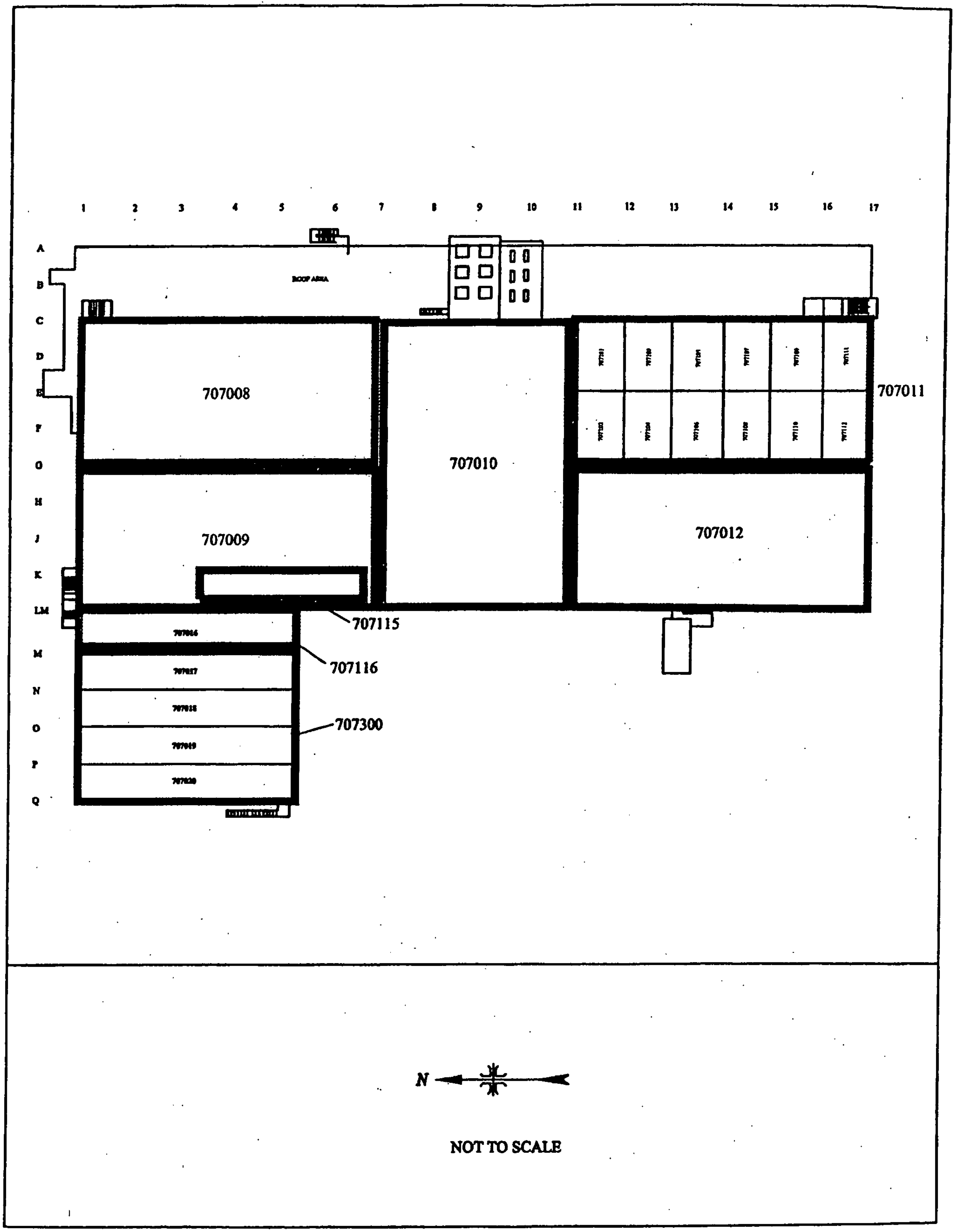


FIGURE 4: Plot Plan of the Second Floor Building 707 Survey Units

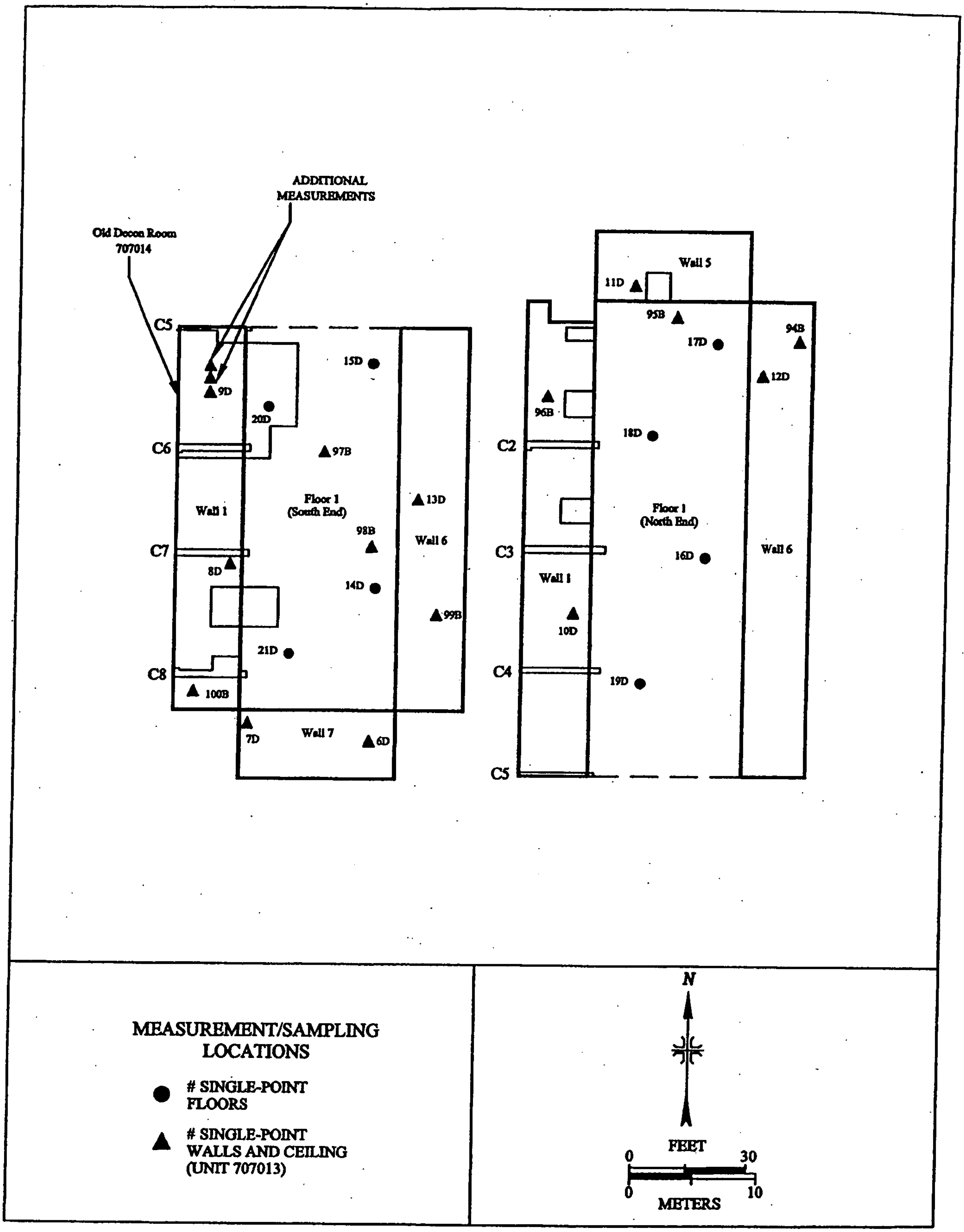
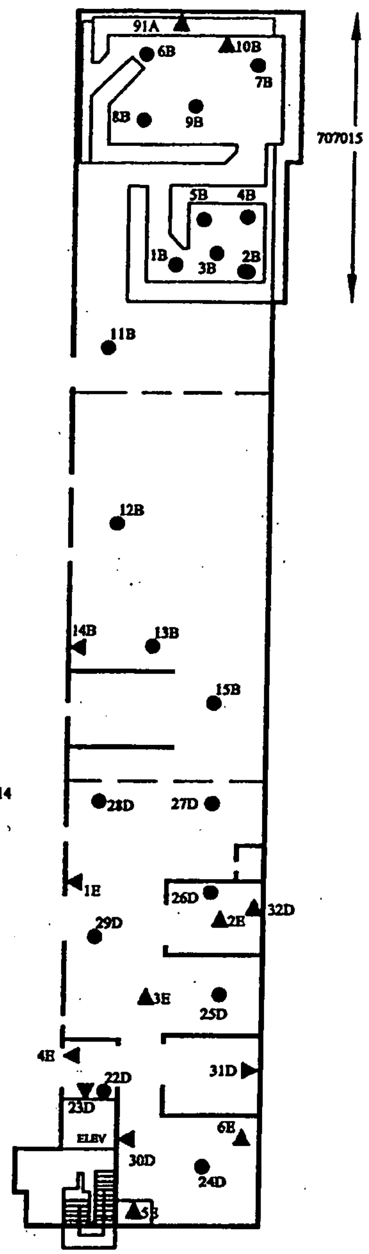


FIGURE 5: Building 707, First Floor, Office Area, Survey Units 707013 and 707014 - Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● # SINGLE-POINT FLOORS

▲ # SINGLE-POINT WALLS AND CEILING (UNIT 707114)

N

NOT TO SCALE

FIGURE 6: Building 707, First Floor, South End, Survey Units 707014, 707015, and 707114 - Measurement and Sampling Locations

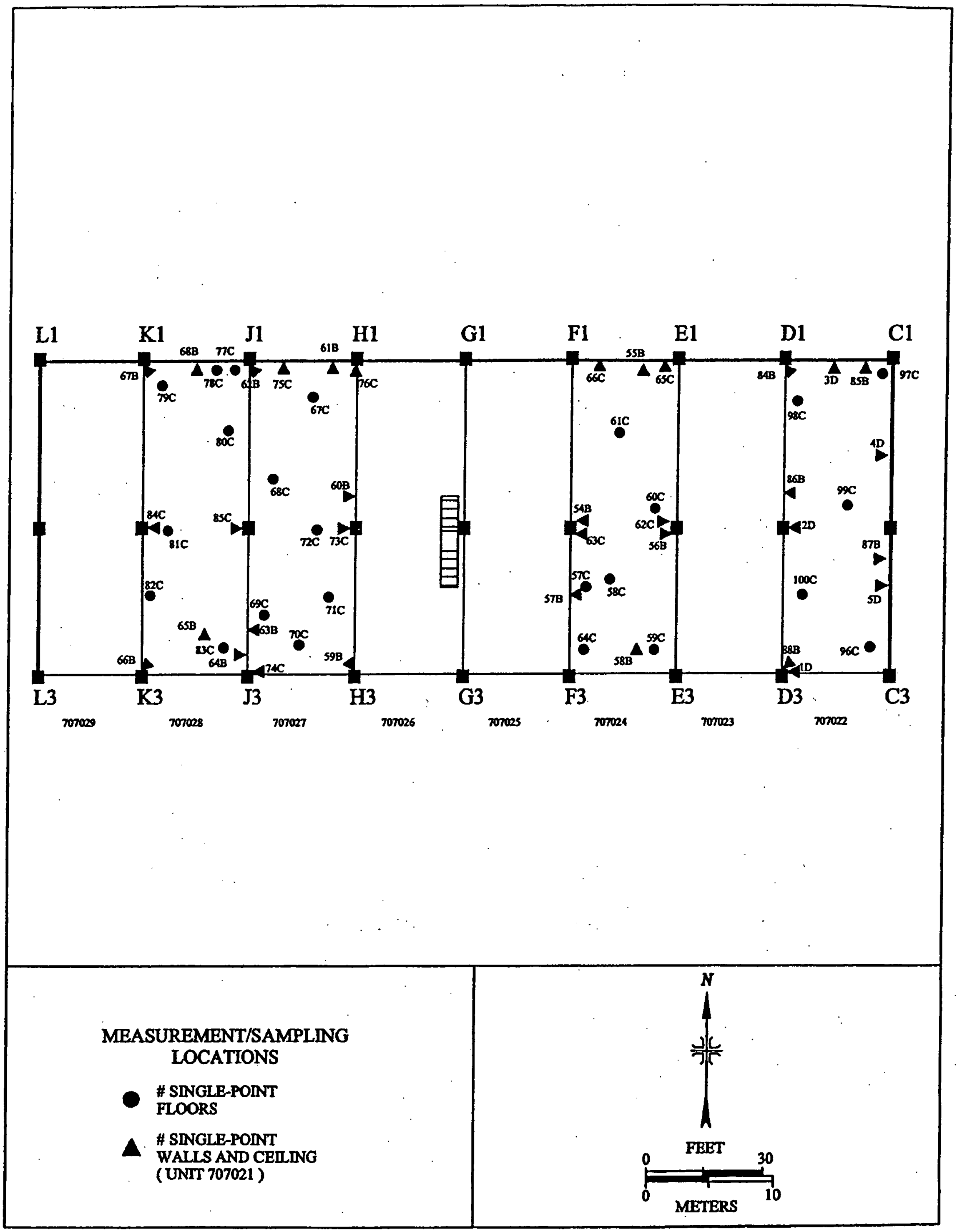


FIGURE 7: Building 707, First Floor, Survey Units 707021-707029 (A Module) - Measurement and Sampling Locations

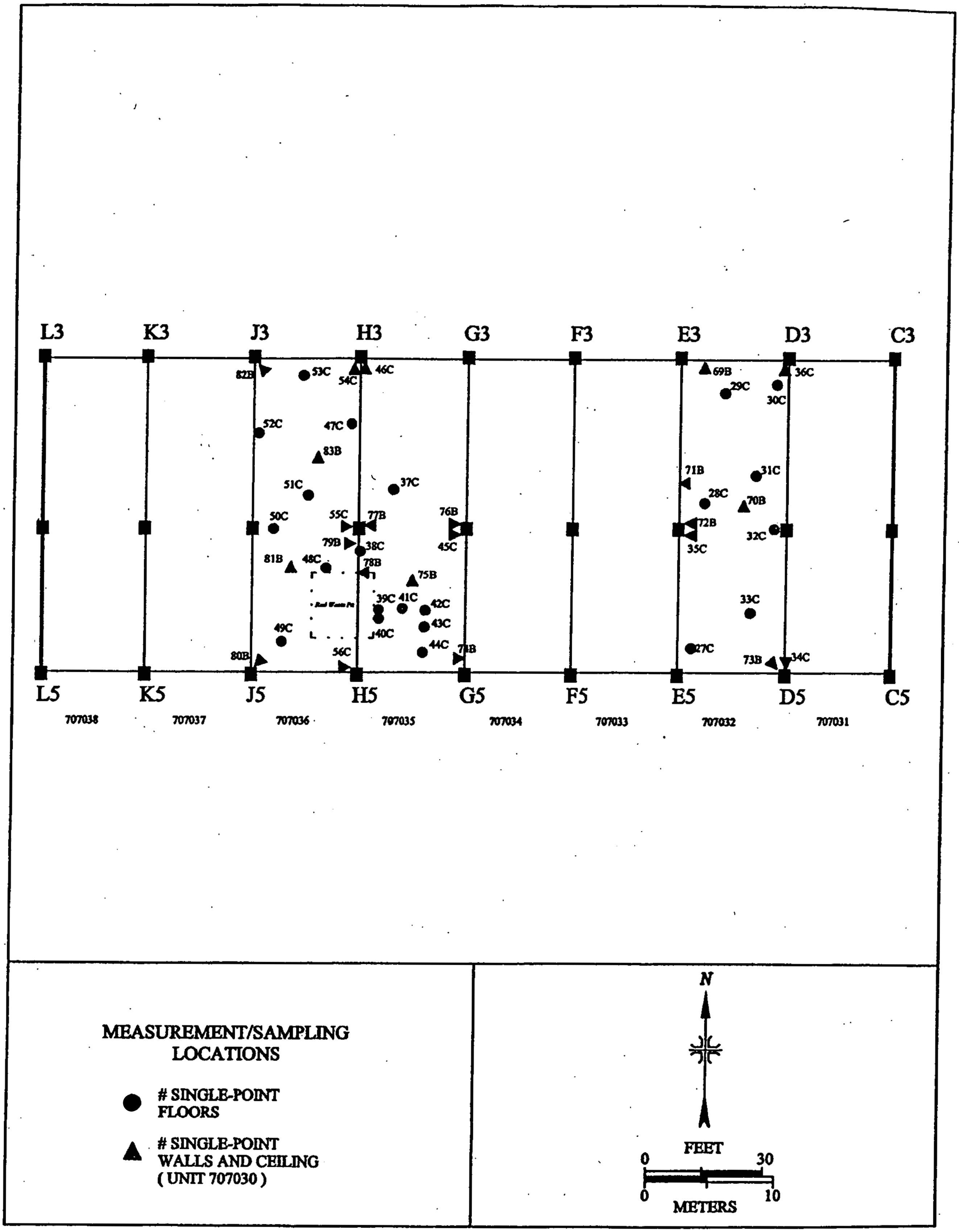


FIGURE 8: **Building 707, First Floor, Survey Units 707030-707038 (B Module) - Measurement and Sampling Locations**

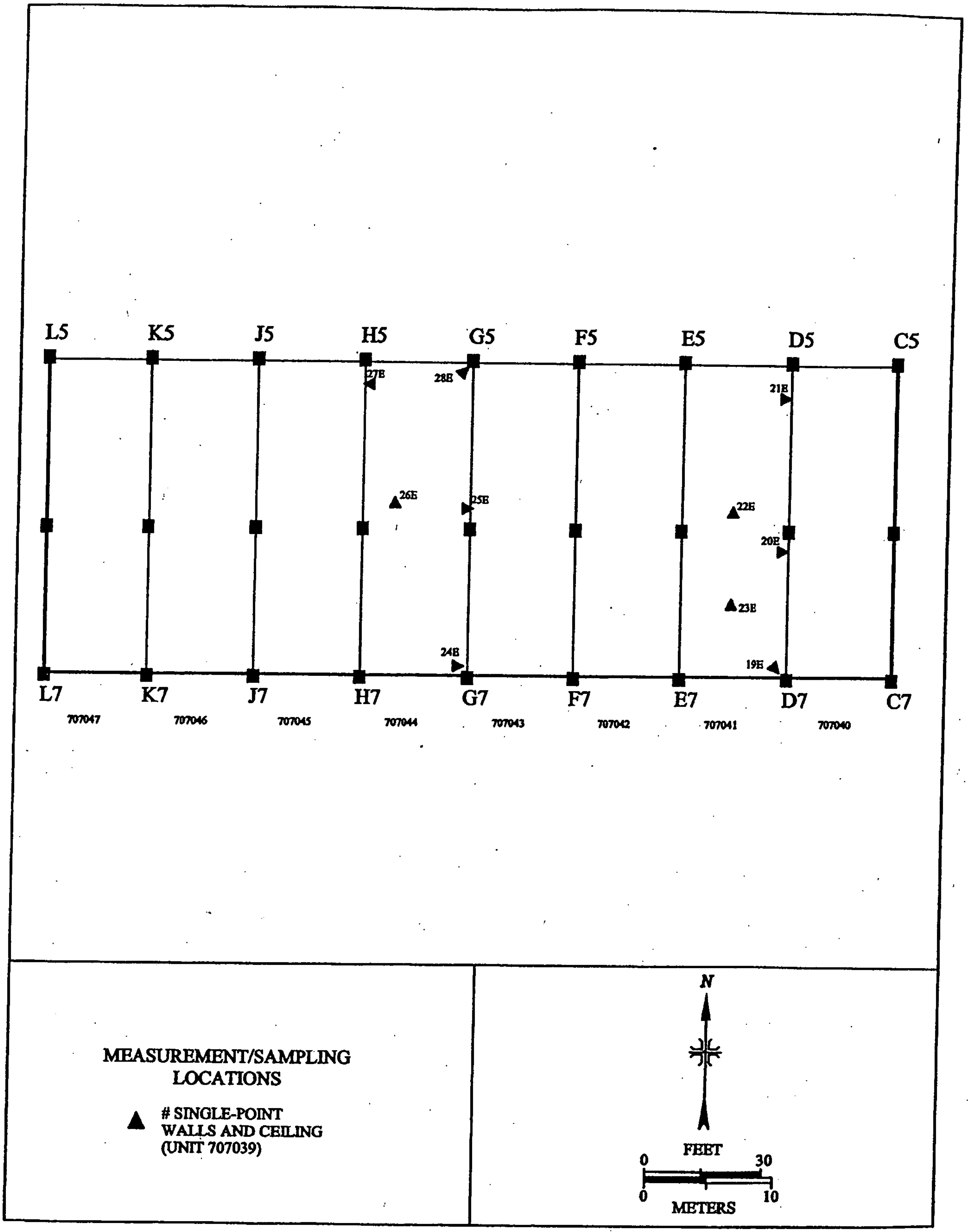


FIGURE 9: Building 707, First Floor, Survey Units 707039-707047 (C Module) - Measurement and Sampling Locations

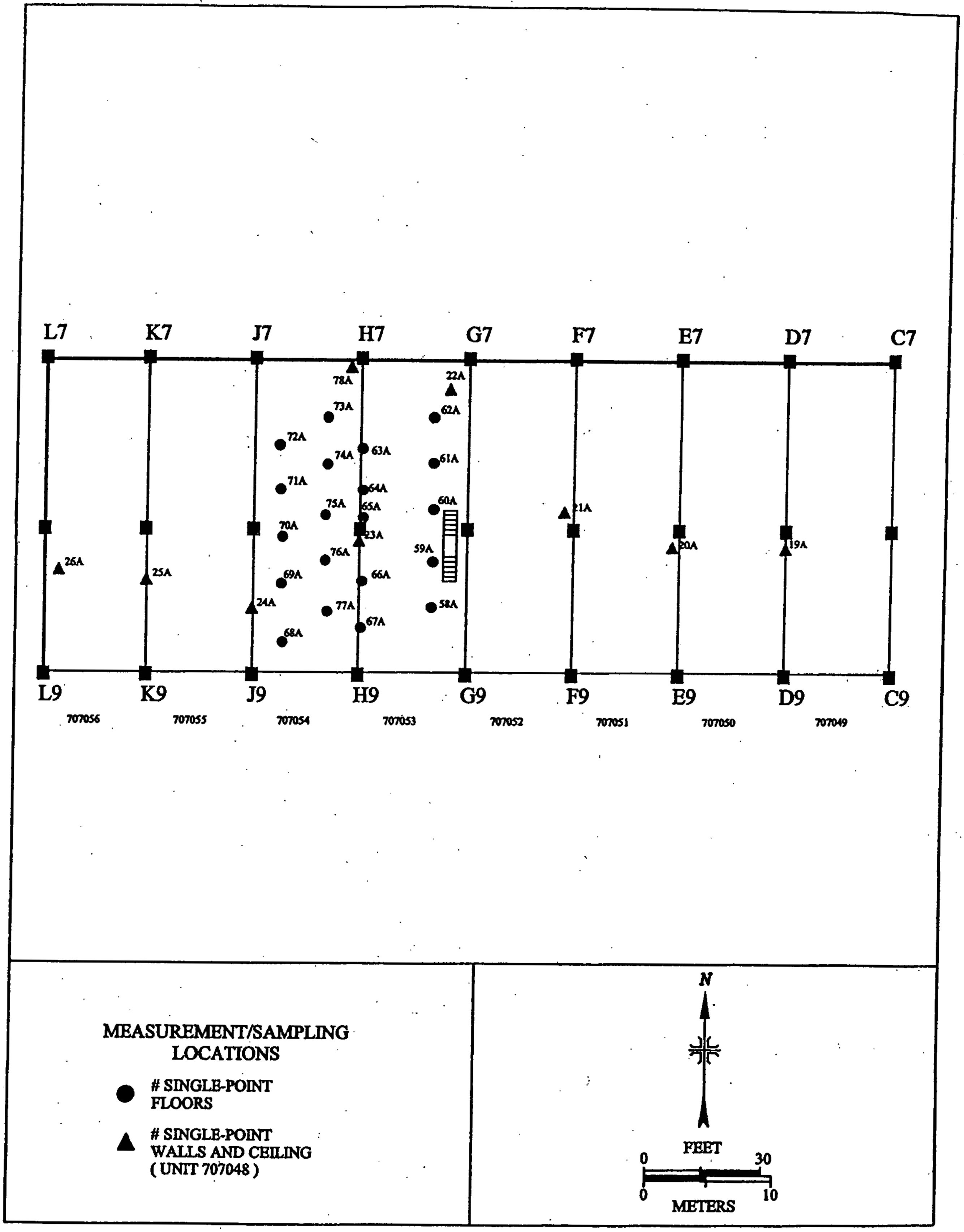


FIGURE 10: Building 707, First Floor, Survey Units 707048-707056 (D Module) - Measurement and Sampling Locations

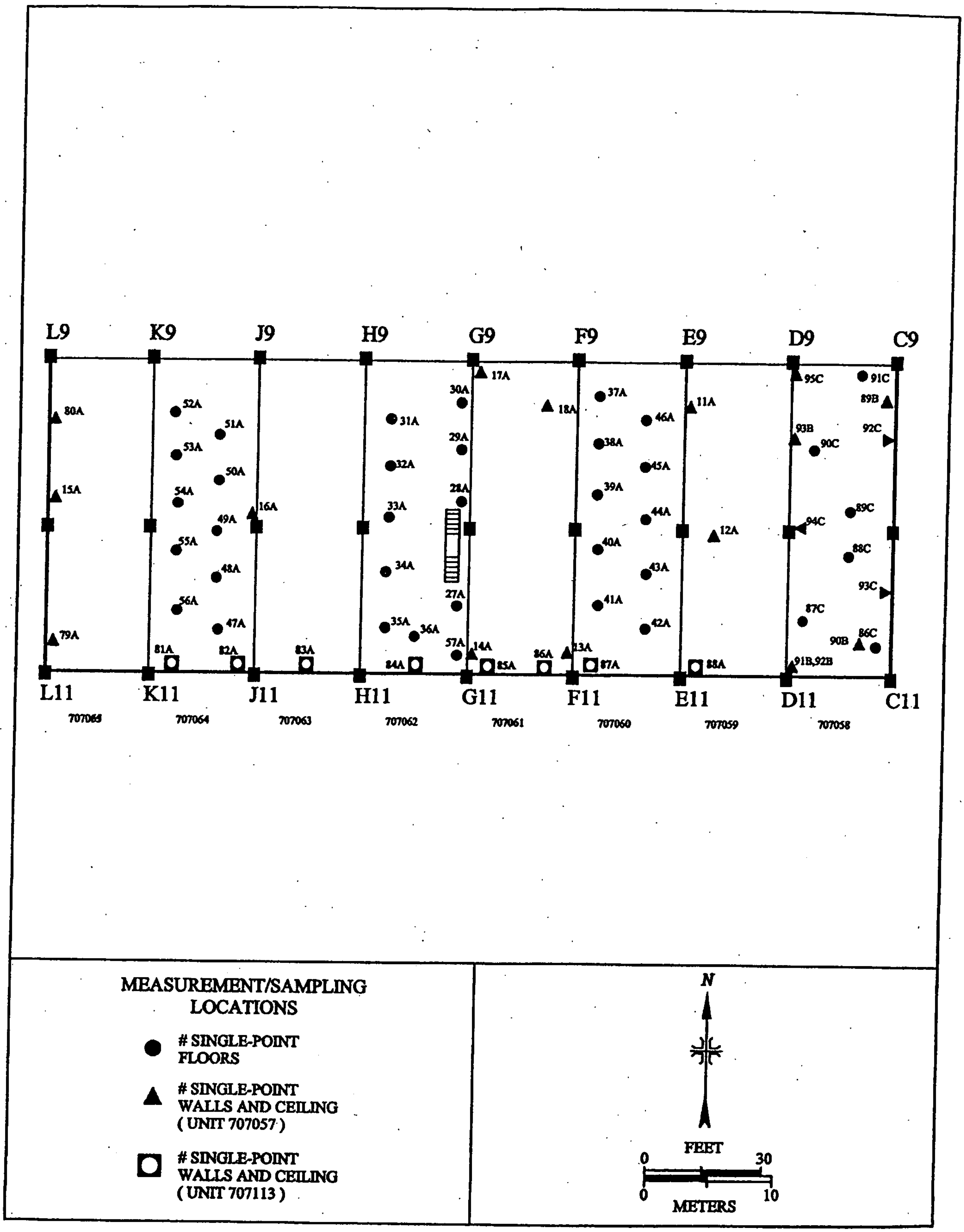


FIGURE 11: Building 707, First Floor, Survey Units 707057-707065 and 707113 (E Module) - Measurement and Sampling Locations

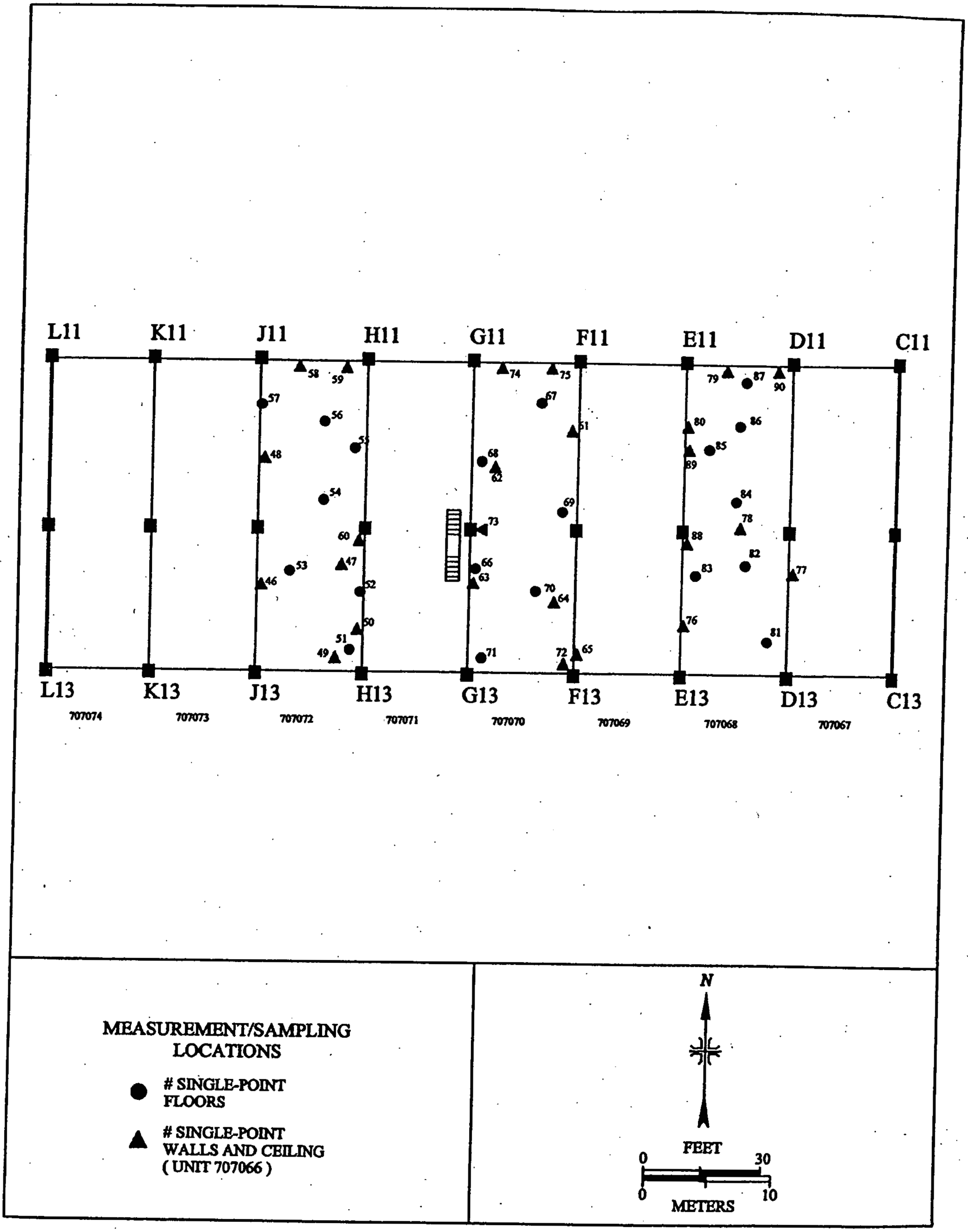


FIGURE 12: Building 707, First Floor, Survey Units 707066-707074 (F Module) - Measurement and Sampling Locations

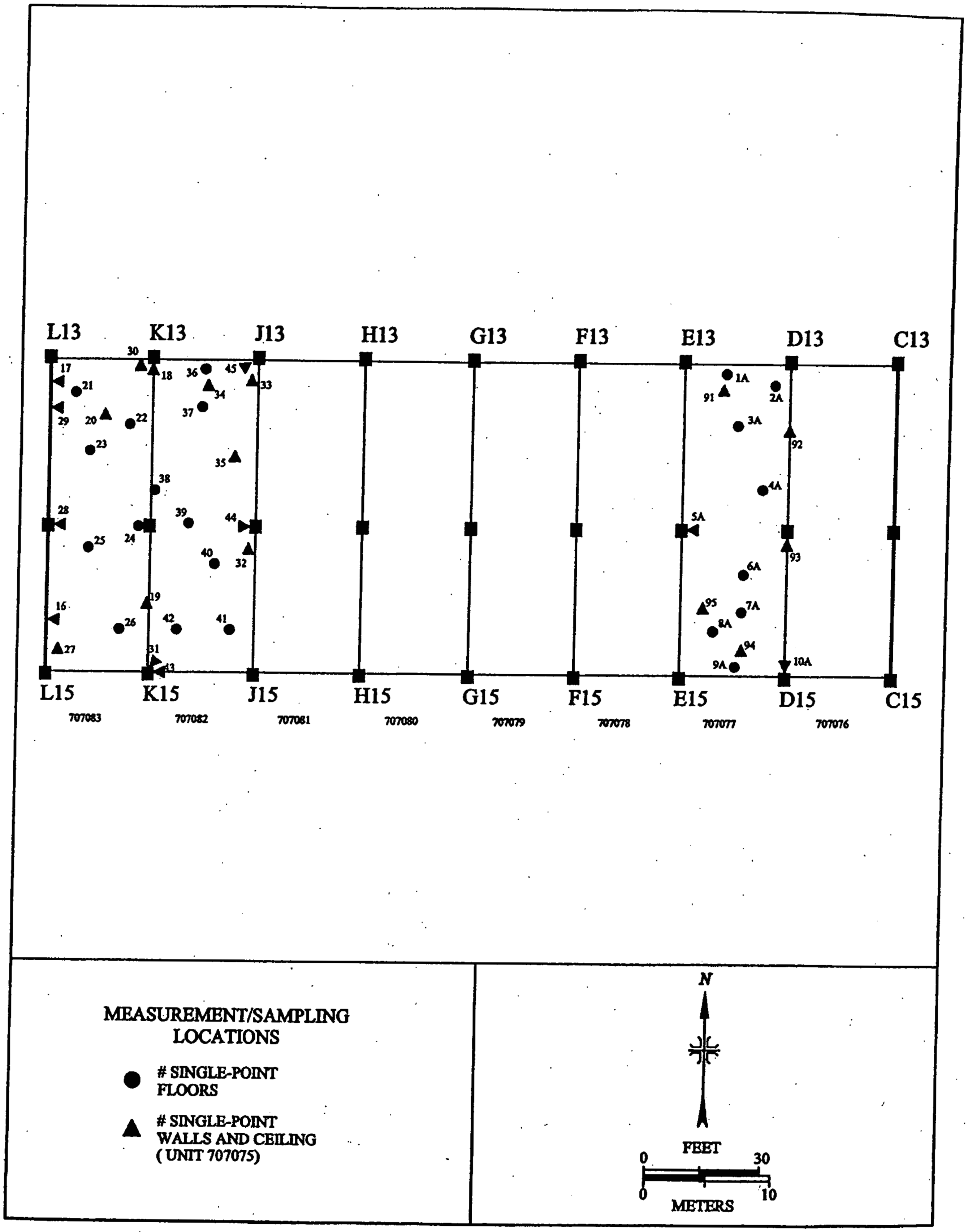


FIGURE 13: Building 707, First Floor, Survey Units 707075-707083 (G Module) - Measurement and Sampling Locations

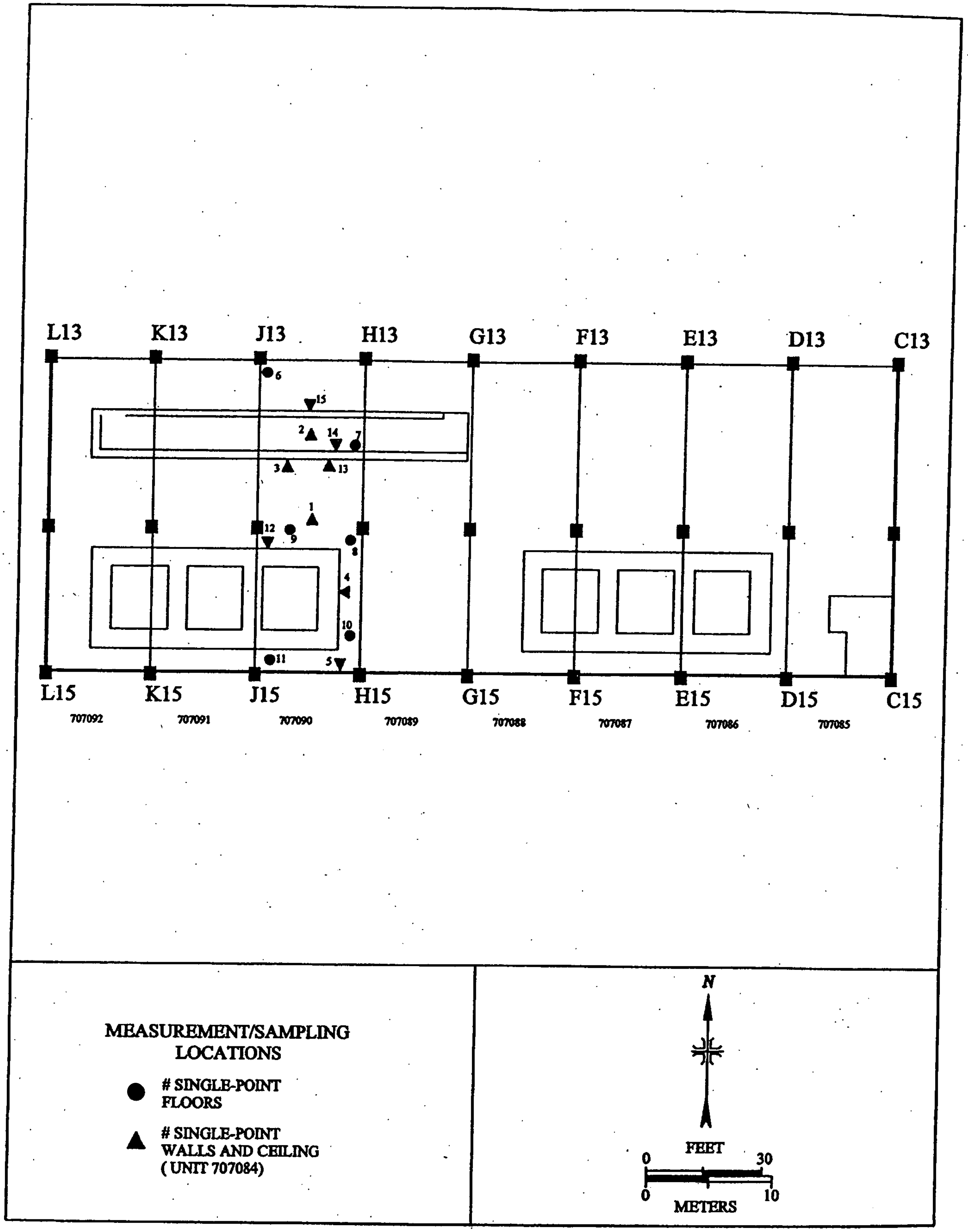


FIGURE 14: Building 707, First Floor, Survey Units 707084-707092 (H Module) - Measurement and Sampling Locations

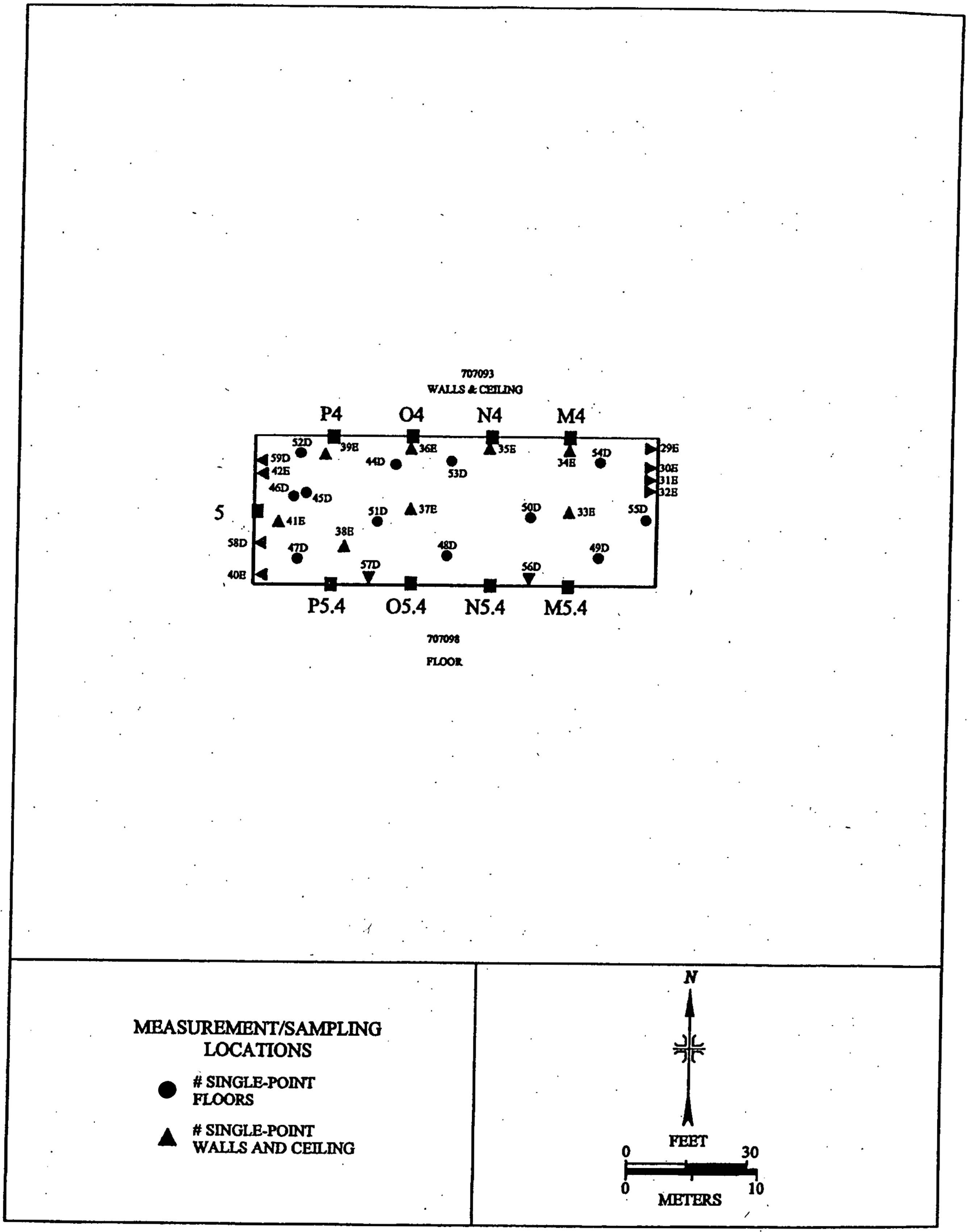
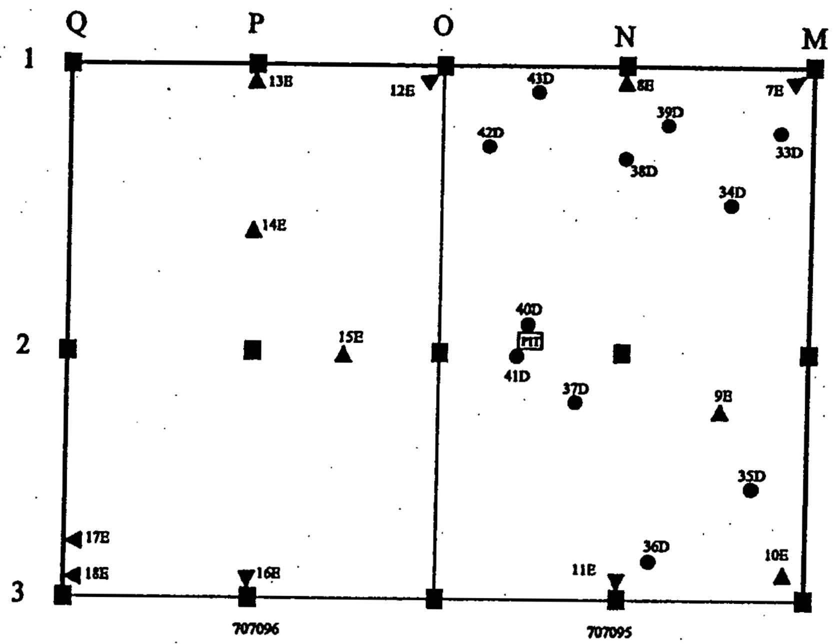
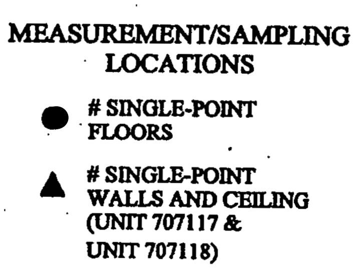


FIGURE 15: Building 707, First Floor, South End, Survey Units 707093 and 707098 (K Module) - Measurement and Sampling Locations





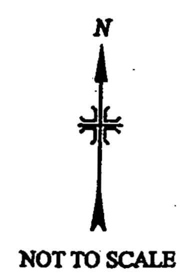


FIGURE 16: Building 707, First Floor, Survey Units 707095, 707096, 707117, and 707118 (J Module) - Measurement and Sampling Locations

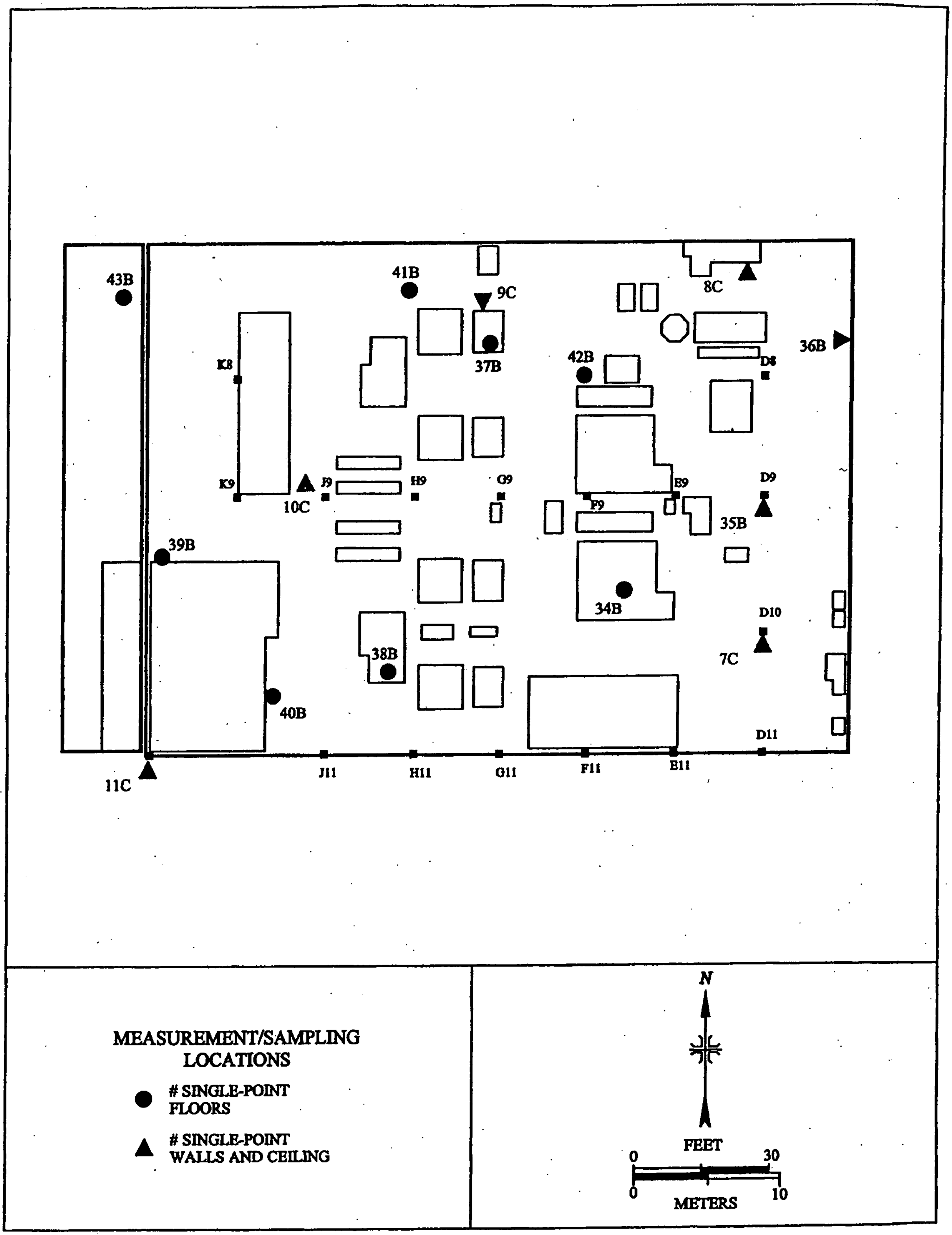


FIGURE 17: Building 707, Second Floor, Survey Unit 707010 - Measurement and Sampling Locations

150

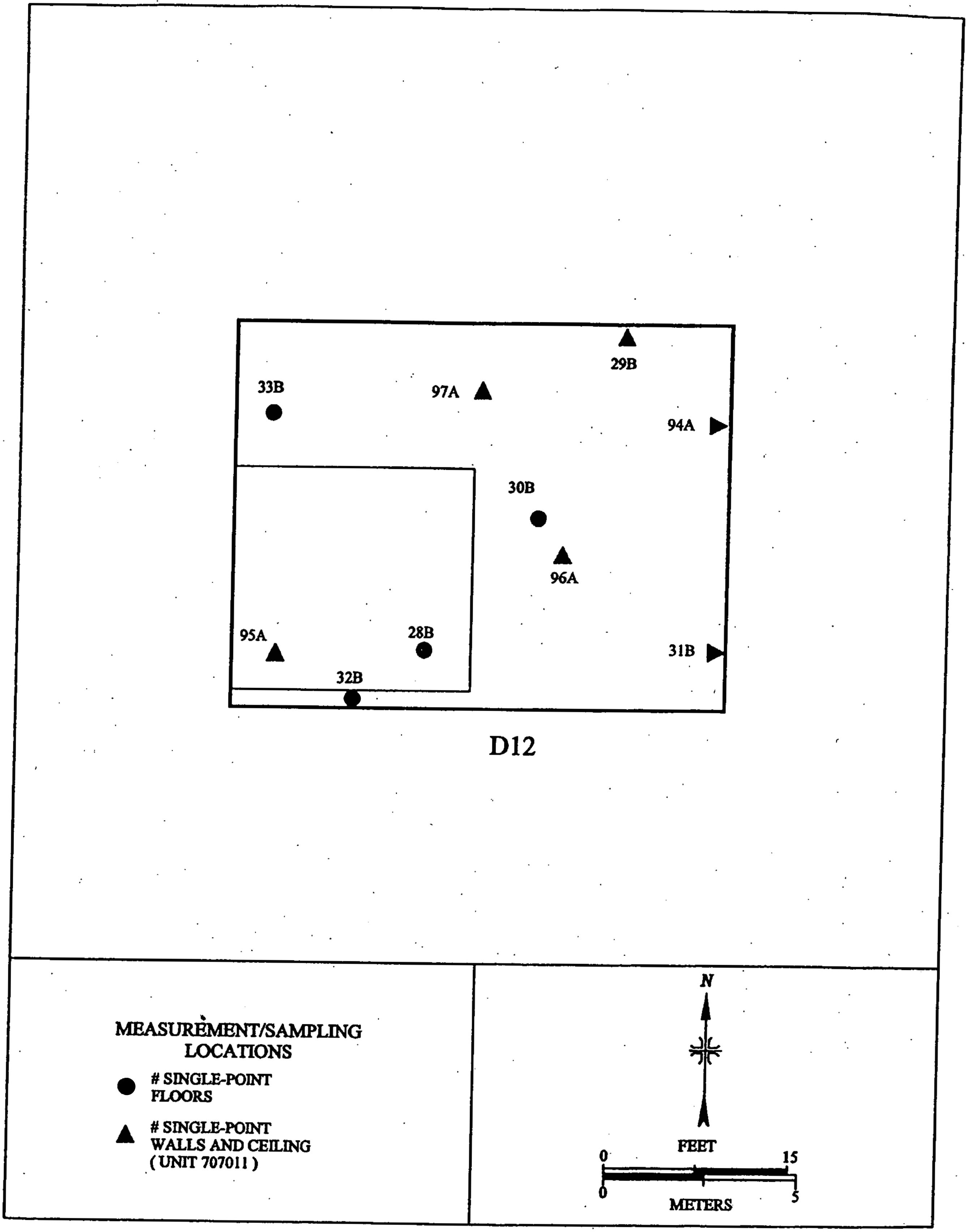


FIGURE 18: Building 707, Second Floor, Survey Units 707011 and 707101 - Measurement and Sampling Locations

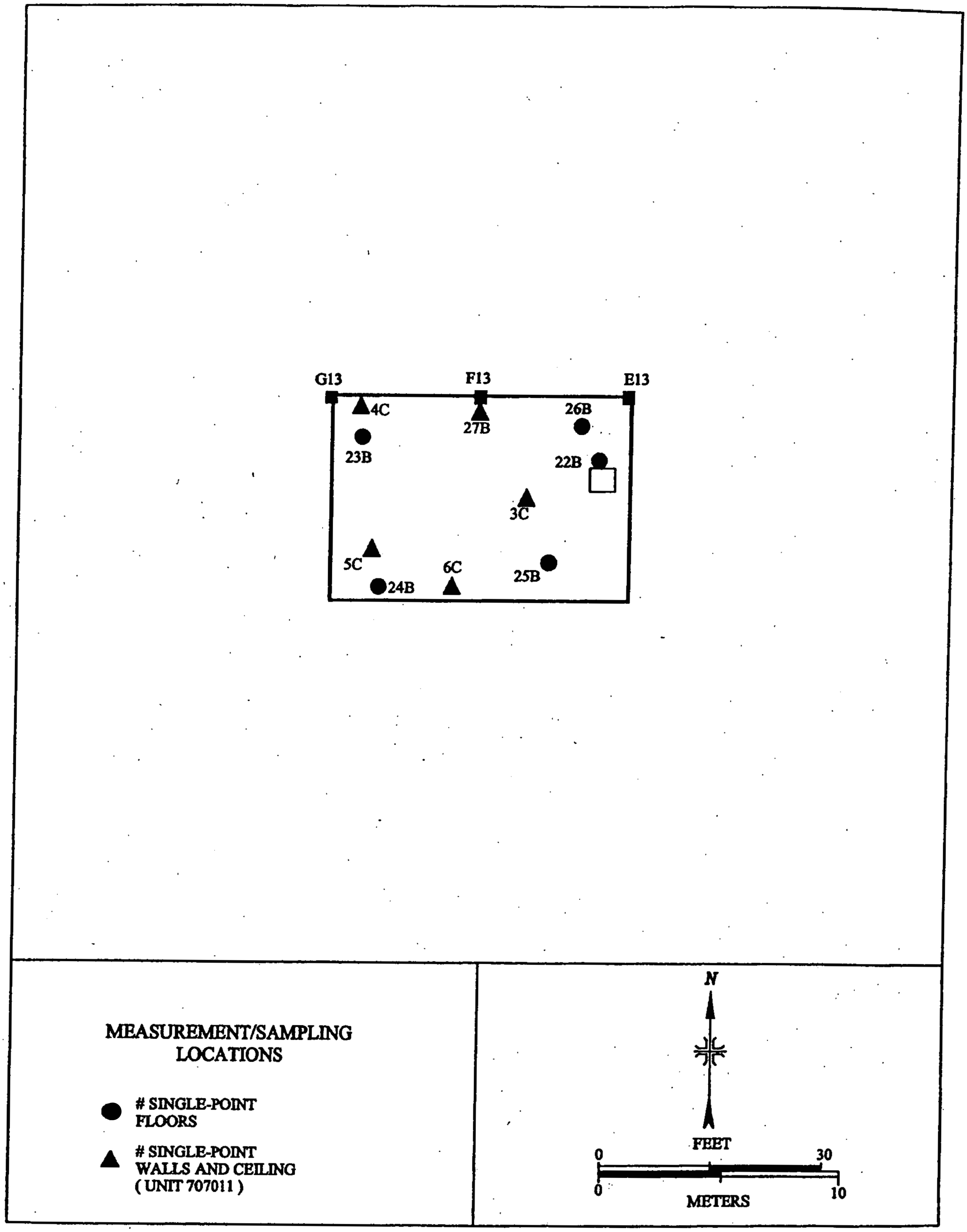


FIGURE 19: Building 707, Second Floor, Survey Units 707011 and 707106 - Measurement and Sampling Locations

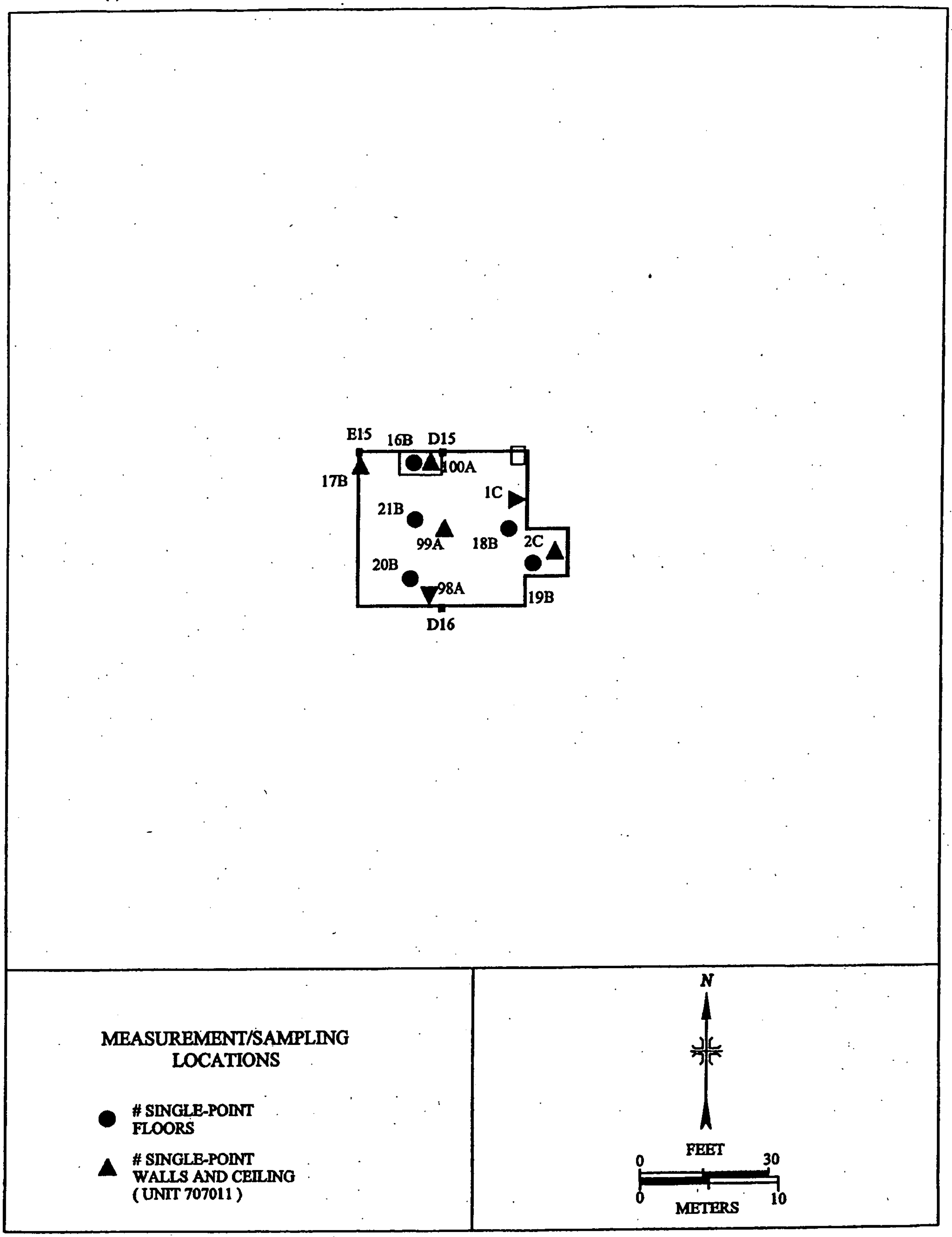


FIGURE 20: Building 707, Second Floor, Survey Units 707011 and 707109 - Measurement and Sampling Locations

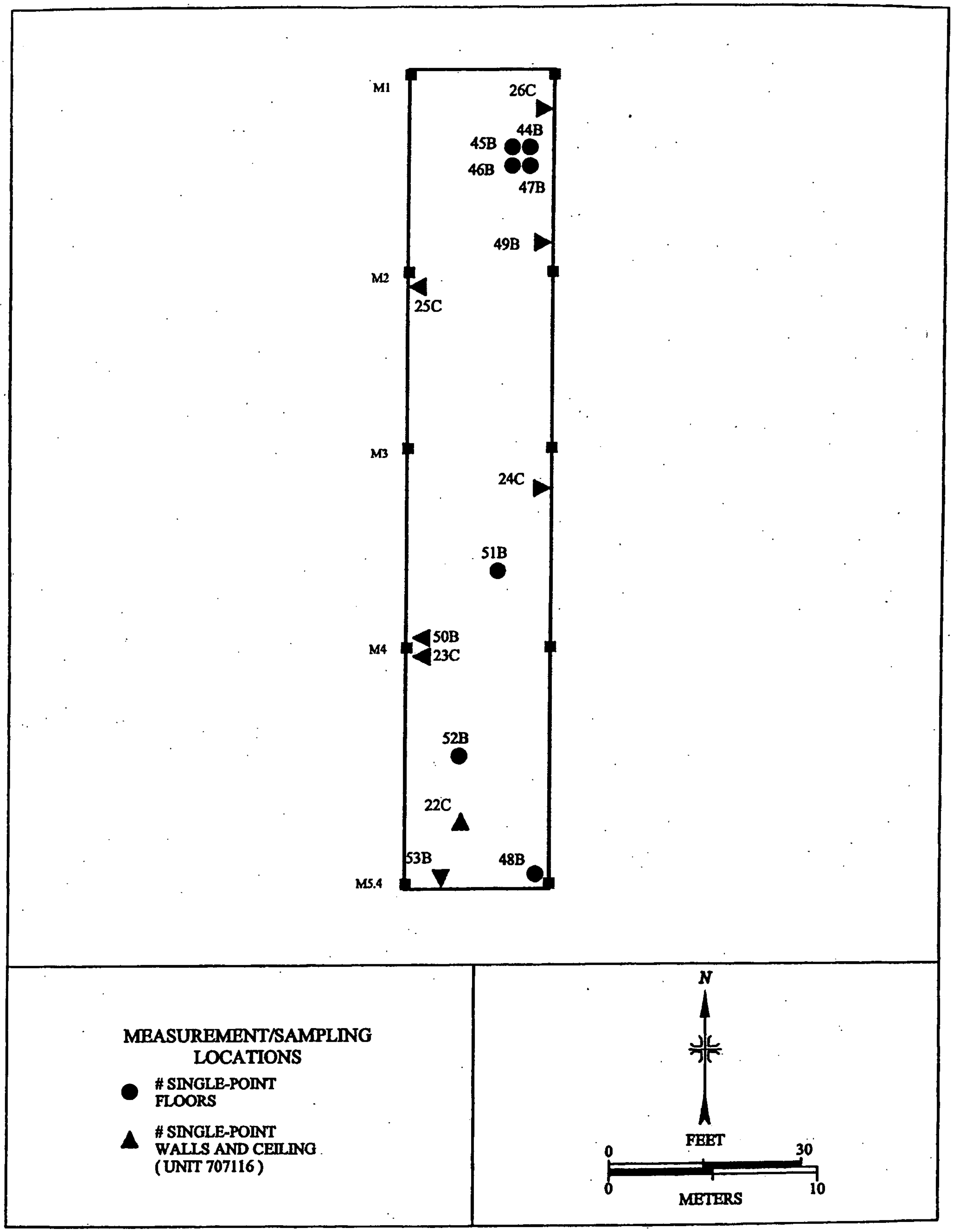


FIGURE 21: Building 707, Second Floor Annex, Survey Units 707016 and 707116 - Measurement and Sampling Locations

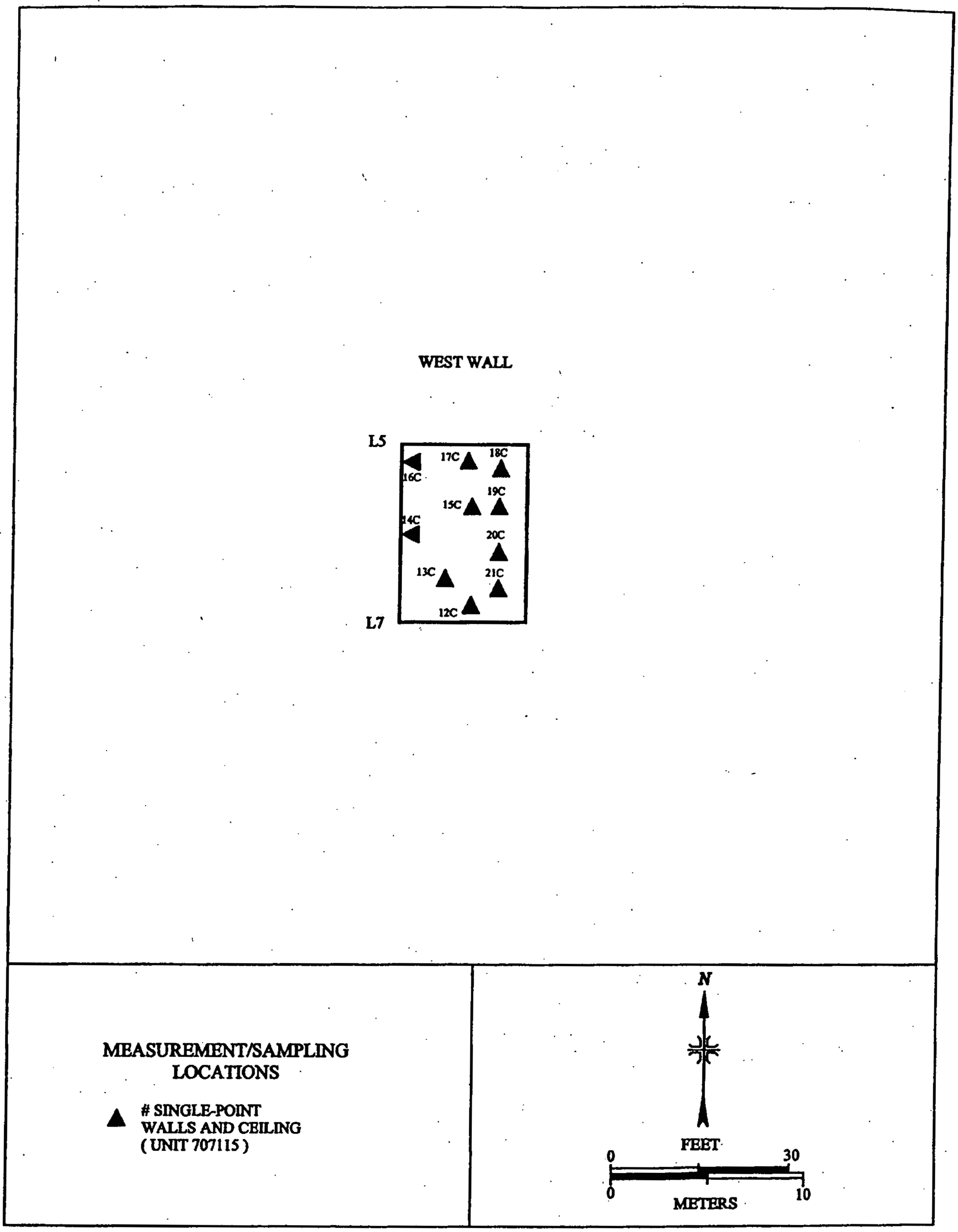


FIGURE 22: Building 707, Second Floor, Survey Unit 707115 - Measurement and Sampling Locations

TABLES

TABLE 1

INITIAL TOTAL AND REMOVABLE ALPHA ACTIVITY MEASUREMENT RANGES
BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO[a]

Survey Unit	Survey Module	Survey Unit Classification	Number of Direct Measurements	Number of Direct Measurements in excess of 300 dpm/100 cm²	Total Alpha Activity Range (dpm/100 cm²)	Removable Activity Range (dpm/100 cm²)
707010	N/A[b]	2	15	1	-14 to 2,200	0 to 1
707011	N/A	2	17	0	14 to 72	0 to 3
707013	Offices	3	22	0	-14 to 140	0 to 1
707014	Process Rooms & Loading Dock	2	30	6	-36 to 1,600	0 to 76
707015	Rm 167 floor	1	4	0	72 to 110	0
707016	N/A	1	7	5	51 to 1,900	0 to 29
707021	A	2	35	2	-7 to 860	0 to 11
707022	A	1	5	2	58 to 1,900	0 to 3
707024	A	1	6	3	65 to 4,600	0 to 270
707027	A	1	6	4	65 to 12,000	0 to 74
707028	A	1	7	2	36 to 380	0 to 3
707030	B	2	23	3	22 to 2,500	0 to 28
707032	B	1	7	0	14 to 140	0 to 3
707035	B	1	8	6	79 to 9,500	0 to 470
707036	B	1	7	1	58 to 2,700	0 to 1
707039	C	2	10	0	88 to 230	0 to 3
707048	D	2	9	1	14 to 1,500	0 to 7
707053	D	1	10	0	36 to 120	0 tol
707054	D	1	10	0	29 to 110	0 tol
707057	E	2	19	5	0 to 3,800	0 to 3

TABLE 1 (Continued)

INITIAL TOTAL AND REMOVABLE ALPHA ACTIVITY MEASUREMENT RANGES
BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO[a]

Survey Unit	Survey Module	Survey Unit Classification	Number of Direct Measurements	Number of Direct Measurements in > 300 dpm/100 cm^2	Total Alpha Surface Activity Range (dpm/100 cm^2)	Removable Activity Range (dpm/100 cm^2)
707058	E	1	6	0	7 to 100	0 to 1
707060	E	1	10	0	36 to 170	0 to 3
707062	E	1	11	1	0 to 1,600	0 to 3
707064	E	1	10	0	7 to 100	0 to 1
707066	F	2	25	1	-29 to 400	0 to 3
707068	F	1	7	0	29 to 87	0 to 7
707070	F	1	6	2	22 to 4,700	0 to 13
707072	F	1	7	0	7 to 190	0 to 5
707075	G	2	24	1	-22 to 790	0 to 9
707077	G	1	8	0	58 to 180	0 to 1
707082	G	1	7	0	72 to 150	0
707083	G	1	6	0	0 to 180	0 to 1
707084	H	2	9	0	-22 to 36	0 to 1
707090	H	1	6	1	0 to 450	0 to 3
707093	K	2	18	7	36 to 3,900	0 to 5
707095	J	1	11	8	65 to 31,000	0 to 250
707098	K	1	12	3	79 to 800	0 to 7
707101	N/A	1	4	0	7 to 220	0 to 1
707106	N/A	1	5	1	36 to 710	0 to 3
707109	N/A	1	5	2	29 to 3,200	0 to 1
707113	E	1	8	1	29 to 350	0 to 3

TABLE 1 (Continued)

INITIAL TOTAL AND REMOVABLE ALPHA ACTIVITY MEASUREMENT RANGES
BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO[a]

Survey Unit	Survey Module	Survey Unit Classification	Number of Direct Measurements	Number of Direct Measurements > 300 dpm/100 cm^2	Total Alpha Surface Activity Range (dpm/100 cm^2)	Removable Activity Range (dpm/100 cm^2)
707114	Walls only	1	3	0	7 to 200	0
707115	N/A	1	10	0	-7 to 72	0 to 3
707116	N/A	1	8	1	14 to 2,700	0 to 72
707117	J	2	5	1	71 to 390	0 to 1
707118	J	2	7	3	53 to 2,300	0 to 22

[a]Table from ORISE Interim Letter Report dated November 24, 2004.
[b]N/A = Second floor survey area. No specific survey module designation indicated.

TABLE 2

POST-REMEDIAL ACTION SURFACE ACTIVITY LEVELS
BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO[a]

Survey Unit	Survey Module	Survey Unit Classification	Number of Measurements Greater than 300 dpm/100 cm²	Initial Alpha Activity Range (dpm/100 cm²)	Post-Remedial Action Measurements Alpha Activity Range (dpm/100 cm²)
707010	N/A	2	1	-14 to 2,200	65
707014	Process Rooms & Loading Dock	2	6	-36 to 1,600	[b,f]
707016	N/A	1	5	51 to 1,900	250[c,e]
707021	A	2	2	-7 to 860	[b,f]
707022	A	1	2	58 to 1,900	94 to 110
707024	A	1	3	65 to 4,600	120 to 220
707027	A	1	4	65 to 12,000	72 to 210[b,d,e]
707028	A	1	2	36 to 380	[b,f]
707030	B	2	3	22 to 2,500	58[b,d,e]
707035	B	1	6	79 to 9,500	79 to170[d]
707036	B	1	1	58 to 2,700	120
707048	D	2	1	14 to 1,500	72
707057	E	2	5	0 to 3,800	14[b,e]
707062	E	1	1	0 to 1,600	110
707066	F	2	1	-29 to 400	[b]
707070	F	1	2	22 to 4,700	43
707075	G	2	1	-22 to 790	79
707090	H	1	1	0 to 450	150[ff]
707093	K	2	7	36 to 3,900	[b,d,e]
707095	J	1	8	65 to 31,000	29 to 420[b,d,e]
707098	K	1	3	79 to 800	[e]
707106	N/A	1	1	36 to 710	51
707109	N/A	1	2	29 to 3,200	65[c]
707113	E	1	1	29 to 350	[b,c]
707116	N/A	1	1	14 to 2,700	110

TABLE 2 (Continued)

POST-REMEDIAL ACTION SURFACE ACTIVITY LEVELS
BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO[a]

Survey Unit	Survey Module	Survey Unit Classification	Number of Measurements Greater than 300 dpm/100 cm^2	Initial Alpha Activity Range (dpm/100 cm^2)	Post-Remedial Action Measurements Alpha Activity Range (dpm/100 cm^2)
707117	J	2	1	71 to 390	[b,e]
707118	J	2	3	53 to 2,300	58 to 120

[a]Table was included in the Interim Letter Report dated November 24, 2004 (ORISE 2004).
[b]Equipment removed.
[c]One or more locations remained above guidelines at time of completion of IV activities.
[d]Post-remedial action measurement is location with highest activity level of all 5 representative locations
[e] Some remediation was attempted but some location(s) have activity that will be controlled during the building demolition or subsequent removal of the floor slab.
[f]All locations were not rechecked after remediation.
[ff]Post-remedial action measurement is the average of 5 point measurements collected at this location.

TABLE 3

SURFACE ACTIVITY LEVELS
BUILDING 707
2ND FLOOR
SURVEY UNIT 707010
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
34B	36	0
35B	14	0
36B	36	1
37B	65	0
38B	29	0
39B	2,200	0
39B[c]	65	N/A[d]
40B	14	0
41B	29	0
42B	-14	0
43B	51	0
7C	58	1
8C	22	0
9C	29	0
10C	72	0
11C	51	0

[a]Refer to Figure 17.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not Applicable.

TABLE 4

SURFACE ACTIVITY LEVELS
BUILDING 707
2ND FLOOR
SURVEY UNIT 707011
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
94A	72	0
95A	22	3
96A	36	1
97A	51	3
3C	58	0
4C	65	0
5C	65	1
6C	72	1
98A	36	1
99A	14	0
100A	29	0
1C	22	0
2C	43	0
29B	22	0
31B	22	0
27B	36	0
17B	36	0

[a]Refer to Figures 18-20.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 5

SURFACE ACTIVITY LEVELS
BUILDING 707
OFFICES
SURVEY UNIT 707013
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
6D	-14	1
7D	-7	0
8D	-7	1
10D	7	0
11D	58	0
12D	43	1
13D	58	0
14D	140	0
15D	72	0
16D	43	0
17D	58	0
18D	36	1
19D	65	1
21D	58	0
94B	120	0
95B	62	0
96B	120	0
97B	97	0
98B	120	0
99B	97	0
100B	140	1

[a]Refer to Figure 5.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 6

SURFACE ACTIVITY LEVELS
BUILDING 707
PROCESS ROOM & LOADING DOCKS
SURVEY UNIT 707014
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Alpha Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
9D	1,600	76
---[c]	910	N/A[e]
---[c]	910	N/A
20D	170	0
22D	560[d]	1
23D	450	0
24D	79	0
25D	43	0
26D	100	0
27D	140	0
28D	58	1
29D	120	3
30D	29	0
31D	36	0
32D	43	0
1E	120	0
2E	88	0
3E	97	1
4E	350	0
5E	250	3
6E	120	0
1B	14	0
2B	7	0
3B	-36	0
4B	14	0
5B	7	0
11B	79	0
12B	22	0
13B	7	0
15B	14	0

[a]Refer to Figures 5 and 6.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]Additional confirmation measurments near 9D, see Figure 5.
[d]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.
[e]N/A – Not Applicable

TABLE 7

SURFACE ACTIVITY LEVELS
BUILDING 707
ROOM 167
SURVEY UNIT 707015
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
6B	72	0
7B	72	0
8B	110	0
9B	100	0

[a]Refer to Figure 6.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 8

SURFACE ACTIVITY LEVELS
BUILDING 707
2ND FLOOR-FLOOR
SURVEY UNIT 707016
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
44B	1,900	29
45B	1,500	0
46B	1,100	0
46B[c]	250	N/A[d]
47B	510	0
48B	570	0
51B	72	1
52B	51	0

[a]Refer to Figure 21.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial Action Measurement.
[d]N/A – Not Applicable.

TABLE 9

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE A
SURVEY UNIT 707021
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
84B	88	0
85B	62	0
86B	71	0
87B	300[d]	11
88B	120	0
1D	36	0
2D	36	0
3D	58	1
4D	7	1
5D	22	3
54B	120	3
55B	0	0
56B	71	0
57B	350[d]	0
58B	71	0
59B	44	0
60B	53	0
61B	35	0
62B	88	0
63B	0	1
64B	71	0
65B	860[c]	0
66B	26	0
67B	97	0
68B	170	0
62C	36	0
63C	65	0
65C	58	0
66C	-7	0
73C	36	1

TABLE 9 (Continued)

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE A
SURVEY UNIT 707021
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
74C	87	0
75C	29	0
76C	58	3
84C	72	0
85C	22	0

[a]Refer to Figure 7.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]Equipment or Material Removed.
[d]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.

TABLE 10

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE A
SURVEY UNIT 707022
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
96C	1,900	0
96C[c]	94	N/A[d]
97C	1,800	3
97C[c]	110	N/A
98C	110	0
99C	94	0
100C	58	0

[a]Refer to Figure 7.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurements.
[d]N/A – Not Applicable.

TABLE 11

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE A
SURVEY UNIT 707024
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
57C	1,100	130
57C[c]	220	N/A[d]
58C	4,600	270
58C[c]	120	N/A
59C	87	3
60C	65	0
61C	170	0
64C	2,600	1
64C[c]	120	N/A

[a]Refer to Figure 7.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurements.
[d]N/A – Not Applicable.

TABLE 12

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE A
SURVEY UNIT 707027
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
67C	850	0
67C[c]	160	N/A[d]
68C	2,300	0
68C[c]	72	N/A
69C	680	3
69C[c]	210	N/A
70C	12,000[e]	74
71C	94	0
72C	65	1

[a]Refer to Figure 7.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurements.
[d]N/A – Not Applicable.
[e]Location to be covered with steel plate and removed during the building demolition.

TABLE 13

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE A
SURVEY UNIT 707028
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
77C	380[c]	3
78C	94	1
79C	87	1
80C	36	1
81C	43	1
82C	320[c]	0
83C	79	0

[a]Refer to Figure 7.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.

TABLE 14

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE B
SURVEY UNIT 707030
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
69B	170	0
70B	88	0
71B	79	0
72B	140	0
73B	110	0
74B	790	0
74B[c]	58	N/A[d]
75B	170	0
76B	180	0
77B	97	1
78B	480	0
79B	130	0
80B	53	0
81B	62	3
82B	71	28
83B	2,500[e]	0
34C	43	0
35C	220	1
36C	72	0
45C	72	0
46C	36	0
54C	79	1
55C	170	0
56C	22	0

[a]Refer to Figure 8.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post remedial action measurement.
[d]N/A – Not applicable.
[e]Location to be covered with steel plate and removed after building demolition.

TABLE 15

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE B
SURVEY UNIT 707032
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
27C	140	0
28C	130	3
29C	43	0
30C	79	0
31C	58	0
32C	110	0
33C	14	0

[a]Refer to Figure 8.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 16

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE B
SURVEY UNIT 707035
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
37C	290	0
38C	260	1
39C	9,500[e]	1
40C	3,000[e]	1
41C	1,400	470
41C[c]	79	N/A[d]
42C	650	1
42C[c]	170	N/A
43C	990	0
43C[c]	120	N/A
44C	760	0
44C[c]	170	N/A

[a]Refer to Figure 8.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.
[e]Location to be covered with steel plate and removed after building demolition.

TABLE 17

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE B
SURVEY UNIT 707036
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
47C	2,700	0
47C[c]	120	N/A[d]
48C	120	1
49C	58	0
50C	79	0
51C	160	0
52C	120	0
53C	87	1

[a]Refer to Figure 8.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.

TABLE 18

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE C
SURVEY UNIT 707039
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
19E	180	1
20E	130	1
21E	230	0
22E	180	3
23E	160	0
24E	110	0
25E	88	0
26E	97	0
27E	130	0
28E	180	0

[a]Refer to Figure 9.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 19

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE D
SURVEY UNIT 707048
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
78A	22	0
19A	1,500	0
19A[c]	72	N/A[d]
20A	290	0
21A	220	0
22A	14	0
23A	150	1
24A	79	1
25A	170	7
26A	150	1

[a]Refer to Figure 10.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.

TABLE 20

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE D
SURVEY UNIT 707053
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
58A	72	1
59A	58	0
60A	36	0
61A	72	0
62A	51	0
63A	36	0
64A	36	0
65A	43	1
66A	65	0
67A	120	1

[a]Refer to Figure 10.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 21

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE D
SURVEY UNIT 707054
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
68A	51	0
69A	43	0
70A	51	0
71A	36	0
72A	110	0
73A	65	0
74A	29	1
75A	87	0
76A	94	0
77A	100	1

[a]Refer to Figure 10.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 22

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE E
SURVEY UNIT 707057
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
11A	79	0
12A	43	0
13A	350[e]	0
14A	590[e]	3
15A	51	0
16A	58	0
17A	100	1
18A	22	0
79A	29	0
80A	65	0
92C	0	0
93C	7	1
94C	29	0
95C	79	0
89B	200	0
90B	53	0
91B	1,500	3
91B[c]	14	N/A[d]
92B	3,800[f]	3
93B	520[e]	0

[a]Refer to Figure 11.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.
[e]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.
[f]Activity remains. Contamination can not be cleaned. The activity location is on a piece of structural steel.

TABLE 23

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE E
SURVEY UNIT 707058
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
86C	22	1
87C	100	1
88C	87	0
89C	7	0
90C	65	0
91C	43	0

[a]Refer to Figure 11.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 24

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE E
SURVEY UNIT 707060
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
37A	65	0
38A	79	0
39A	36	3
40A	72	1
41A	36	0
42A	79	1
43A	51	0
44A	65	0
45A	94	3
46A	170	0

[a]Refer to Figure 11.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 25

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE E
SURVEY UNIT 707062
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
57A	0	1
27A	36	1
28A	72	1
29A	94	0
30A	36	3
31A	58	0
32A	72	0
33A	100	3
34A	65	1
35A	87	0
36A	1,600	0
36A[c]	110	N/A[d]

[a]Refer to Figure 11.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.

TABLE 26

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE E
SURVEY UNIT 707064
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
47A	72	0
48A	94	0
49A	87	1
50A	65	0
51A	100	0
52A	14	0
53A	65	1
54A	7	1
55A	94	0
56A	36	1

[a]Refer to Figure 11.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 27

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE F
SURVEY UNIT 707066
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
46	400[c]	0
47	65	0
48	230	3
49	58	0
50	120	1
58	29	0
59	72	0
60	29	0
61	36	0
62	29	0
63	43	1
64	58	0
65	29	0
72	0	0
73	22	0
74	-29	0
75	0	0
76	43	0
77	29	0
78	43	1
79	94	0
80	0	0
88	0	0
89	210	1
90	22	0

[a]Refer to Figure 12.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.

TABLE 28

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE F
SURVEY UNIT 707068
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
81	51	0
82	87	1
83	29	0
84	87	0
85	72	7
86	58	0
87	29	0

[a]Refer to Figure 12.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 29

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE F
SURVEY UNIT 707070
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
66	4,700	13
66[c]	43	N/A[d]
67	65	0
68	4,700	1
68[c]	43	N/A[d]
69	100	1
70	22	1
71	51	0

[a]Refer to Figure 12.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.

TABLE 30

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE F
SURVEY UNIT 707072
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
51	14	0
52	100	5
53	29	1
54	36	1
55	130	0
56	7	1
57	190	1

[a]Refer to Figure 12.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 31

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE G
SURVEY UNIT 707075
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
16	100	0
17	7	0
18	36	0
19	14	1
20	51	1
27	29	0
28	51	0
29	7	0
30	79	0
31	43	0
32	29	0
33	140	0
34	43	0
35	29	0
43	22	0
44	43	0
45	29	1
91	790	9
91[c]	79	N/A[d]
92	43	0
93	58	0
94	65	1
95	43	0
5A	-22	3
10A	14	1

[a]Refer to Figure 13.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.

TABLE 32

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE G
SURVEY UNIT 707077
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
1A	130	0
2A	58	1
3A	94	1
4A	65	1
6A	58	0
7A	140	1
8A	58	1
9A	180	0

[a]Refer to Figure 13.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 33

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE G
SURVEY UNIT 707082
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
36	87	0
37	94	0
38	100	0
39	87	0
40	150	0
41	72	0
42	130	0

[a]Refer to Figure 13.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 34

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE G
SURVEY UNIT 707083
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
21	150	0
22	22	1
23	0	0
24	180	1
25	87	0
26	120	0

[a]Refer to Figure 13.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 35

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE H
SURVEY UNIT 707084
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
1	36	1
2	36	0
3	22	0
4	7	1
5	14	0
12	-22	0
13	0	0
14	14	0
15	7	0

[a]Refer to Figure 14.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 36

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE H
SURVEY UNIT 707090
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
6	43	0
7	29	1
8	450	0
8[c]	150[e]	N/A[d]
9	94	0
10	51	0
11	0	3

[a]Refer to Figure 14.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.
[e]Activity calculated by performing 5 point average.

TABLE 37

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE K
SURVEY UNIT 707093
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
56D	36	0
57D	58	1
58D	400[d]	0
59D	120	0
29E	1,000[c]	5
30E	3,900[c]	0
31E	1,700[c]	3
32E	1,100[c]	1
33E	920[c]	5
34E	310[d]	0
35E	290	0
36E	210	0
37E	180	0
38E	170	0
39E	190	0
40E	160	1
41E	120	0
42E	210	3

[a]Refer to Figure 15.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]Activity found on east wall of survey unit 707093. Kaiser Hill provided post remedial activity ranges of < 300 dpm/ 100cm^2.
[d]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.

TABLE 38

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE J
SURVEY UNIT 707095
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
33D	970	1
33D[c]	43	N/A[d]
34D	780	0
34D[c]	29	N/A
35D	760	5
35D[c]	420	N/A
36D	380[e]	0
37D	100	0
38D	120	1
39D	87	0
40D	1,400[f]	24
41D	31,000[f]	250
42D	65	0
43D	970	0
43D[c]	130	N/A

[a]Refer to Figure 16.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.
[e]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.
[f]Location to be covered with steel plate and removed after building demolition.

TABLE 39

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE K
SURVEY UNIT 707098
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
44D	530[c,d]	0
45D	800[c,d]	3
46D	690[c,d]	7
47D	120	3
48D	240	0
49D	140	0
50D	120	0
51D	210	0
52D	140	1
53D	130	0
54D	79	1
55D	130	5

[a]Refer to Figure 15.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]The Independent Verification Team painted surfaces to be remediated by Kaiser Hill.
[d]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.

TABLE 40

SURFACE ACTIVITY LEVELS
BUILDING 707
2ND FLOOR
SURVEY UNIT 707101
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
28B[c]	43	0
30B	7	0
32B	29	0
33B	220	1

[a]Refer to Figure 18.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]Equipment location.

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TABLE 41

SURFACE ACTIVITY LEVELS
BUILDING 707
2ND FLOOR
SURVEY UNIT 707106
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
22B[c]	58	0
23B	36	3
24B	87	3
25B	94	3
26B	710	0
26B[d]	51	N/A[e]

[a]Refer to Figure 19.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]Equipment location
[d]PRA – Post Remedial action measurement.
[e]N/A – Not applicable.

TABLE 42

SURFACE ACTIVITY LEVELS
BUILDING 707
2ND FLOOR
SURVEY UNIT 707109
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
16B	87	1
18B	43	0
19B	29	0
20B	3,200	0
20B[c]	65	N/A[d]
21B	411[e]	1

[a]Refer to Figure 20.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.
[e]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.

TABLE 43

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE E
SURVEY UNIT 707113
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
81A	51	1
82A	65	0
83A	72	0
84A	79	1
85A	94	0
86A	43	1
87A	29	0
88A	350[c]	3

[a]Refer to Figure 11.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.

TABLE 44

SURFACE ACTIVITY LEVELS
BUILDING 707
PROCESS ROOMS & LOADING DOCK
SURVEY UNIT 707114
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
91A	200	0
10B	29	0
14B	7	0

[a]Refer to Figure 6.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 45

SURFACE ACTIVITY LEVELS
BUILDING 707
2ND FLOOR
SURVEY UNIT 707115
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
12C	43	0
13C	72	1
14C	43	3
15C	-7	0
16C	22	0
17C	29	0
18C	0	0
19C	14	0
20C	-7	0
21C	7	0

[a]Refer to Figure 22.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 46

SURFACE ACTIVITY LEVELS
BUILDING 707
2ND FLOOR
SURVEY UNIT 707116
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
22C	51	0
23C	2,700	72
23C[c]	110	N/A[d]
24C	14	1
25C	51	0
26C	65	0
49B	100	0
50B	72	1
53B	14	1

[a]Refer to Figure 21.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.

TABLE 47

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE J
SURVEY UNIT 707117
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
7E	130	0
8E	390[c]	0
9E	88	0
10E	110	1
11E	71	0

[a]Refer to Figure 16.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]No decon attempted during initial IV visit. Area subsequently remediated and verified by contractor.

TABLE 48

SURFACE ACTIVITY LEVELS
BUILDING 707
MODULE J
SURVEY UNIT 707118
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	Total Surface Activity[b] (dpm/100 cm^2)	Total Removable Activity (dpm/100 cm^2)
12E	120	0
13E	190	1
14E	1,100	0
14E[c]	120	N/A[d]
15E	53	0
16E	88	3
17E	1,200	22
17E[c]	58	N/A
18E	2,300	5
18E[c]	100	N/A

[a]Refer to Figure 16.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]PRA – Post Remedial action measurement.
[d]N/A – Not applicable.

TABLE 49

COMPARISON MEASUREMENTS
ALPHA SURFACE ACTIVITY LEVELS
SURVEY MODULE C FLOOR
BUILDING 707
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

K-H/Bartlett Measurement Locations	Survey Unit[a]	ESSAP Alpha Activity[b] (dpm/100 cm²)	K-H Alpha Activity[c] (dpm/100 cm²)	Bartlett Alpha Activity[d,e] (dpm/100 cm²)
2	707042	450	204	404
5	707042	5,300	2,076	1,737
25	707042	57,000	24,429	15,000
15	707042	5,700	1,579	345
16	707042	8,200	3,729	383
20	707042	1,200	593	403
33	707042	4,000	1,851	985
31/32	707042	820	255	413/590
15	707042	760	420	345
1	707042	2,000	1,058	413
5	707045	2,500	905	1,477
7	707045	100	54	376
9	707045	26,000	9,005	7,903
13	707046	1,100	312	814

[a]Survey units are located in "C" Module.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.
[c]Measurements obtained using Electra DP-6 100 cm^2 scintillation detector.
[d]Initial characterization survey data reported by Bartlett Final Survey Monitor.
[e]Measurements based on 8 second stamp using a large-area (582 cm^2) gas proportional detector.

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APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Alpha

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Floor Monitor Model 239-1
combined with
Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-37, Physical Area: 550 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Alpha Scintillation Detector Model 43-89 or 43-90, Physical Area: 100 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

DIRECT MEASUREMENT INSTRUMENT

Low Background Gas Proportional Counter
Model LB-5100-W
(Canberra/Tennelec, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

A walkdown of the project area was performed to evaluate the survey areas for potential health and safety issues that may not have been identified by the site. Additionally, the proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in applicable job hazard analyses (JHAs). The procedures entailed minimal potential hazards that were currently addressed in ESSAP JHAs.

Personnel adhered to the site health and safety requirements. Project training requirements were met prior to entry into the survey areas. General employee radiological training for site access was completed and the IV team completed beryllium worker qualification, including on-site physical, chest x-ray, and classroom lecture. In addition, the IV team were trained or informed of building specific entry and safety requirements.

QUALITY ASSURANCE

Calibration

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual (September 2004)
- Laboratory Procedures Manual (August 2004)
- Quality Assurance Manual (August 2004)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1C and the U.S. Nuclear Regulatory Commission Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Instrumentation had to be re-calibrated once at the site because of the effect of altitude on detection capability.

Detectors used for assessing surface activity were calibrated in accordance with ISO-7503[1] recommendations. The total efficiency (ε_{total}) was determined for each instrument/detector combination and consisted of the product of the 2π instrument efficiency (ϵ_i) and surface efficiency (ε_s):

$$\varepsilon_{total} = \varepsilon_i \times \varepsilon_s$$

The alpha calibration efficiency for gas proportional detectors used for the project, calibrated to Am-241 was typically at 0.11. The alpha calibration source was selected based on the alpha energy distribution of the radionuclide of concern. ISO-7503 recommends an ε_s of 0.25 when measuring alpha emitters and beta emitters with a maximum energy of less than 0.4 MeV and an ε_s of 0.5 for maximum beta energies greater than 0.4 MeV.

[1]International Standard. ISO 7503-1, Evaluation of Surface Contamination - Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. August 1, 1988.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detector slowly over the surface; the distance between the detectors and surface was maintained at a minimum, nominally about 1 cm. A large surface area, (550 cm^2) gas proportional floor monitor was used to scan the floors in the low-bay area. Other surfaces were scanned using a small area 126 cm^2 hand-held gas proportional detector or using a 100 cm^2 alpha scintillator detector. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument.

Scanning for alpha emitters must be derived differently than scanning for beta and gamma emitters. For the most part, the background response of most alpha detectors is very close to zero, typically registering no more than 2 or 3 cpm. The equation for alpha scan MDC is based on the MARSSIM equation in Appendix J:

$$\alpha\, scan\ MDC = \frac{\left[-\ln\left(1-P(n \geq 1)\right)\right]60}{\varepsilon_i \varepsilon_s t}$$

Where P(n>1) is the probability of detecting 1 count, and t is the observation interval based on the scan rate (should not be greater than several seconds). In the application of this equation, one must recognize that a point of diminishing returns exists for how large t can be, typically no more than five seconds. That is, increasing the residence time to several seconds will not reduce the scan MDC—i.e., one cannot continue to scan slower and slower to increase t. The nominal scan rate for alpha scanning is determined to range from 2 to 5 cm/s. The probability of detecting one count should be specified as at least 90%, but frequently it will be 95% (i.e., 0.95). Finally, the use of a 100 cm^2 hot spot size allows the calculation of the alpha scan MDC in units of dpm/100 cm^2. Care must be exercised to calculate the alpha instrument efficiency using a 100 cm^2 calibration source.

[2]NUREG-1575. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), U.S. Nuclear Regulatory Commission. Washington, DC; June 2001.

As an example, consider evaluating the scan MDC for Pu-239 on a concrete slab. Assume that the scan speed (3 cm/s) is such that a residence time of 3.33 seconds is maintained over the contamination. The instrument efficiency is assumed to be 0.44 and the surface efficiency according to ISO-7503 is 0.25. Therefore, the scan MDC is based on a 90% probability of detecting one count:

$$\alpha\ scan\ MDC = \frac{[-\ln(1-0.9)]\,60}{(0.44)(0.25)(3.33)} = 380\ dpm/100\ cm^2$$

For backgrounds greater than zero, e.g., 1 to 3 cpm, the calculational approach and scan MDC result are still valid, however, it is at the expense of an increased false positive rate. That is, the surveyor will be more likely to mistake background as contamination. For background count rate on the order of 5 to 10 cpm, a single count should not cause a surveyor to investigate further, primarily because there would be an inordinate amount of false positives.

Specific scan MDCs for the NaI scintillation detector for the radionuclide mixture in concrete were not determined as the instrument was used solely as a qualitative means to identify elevated gamma activity. MDCs for radionuclides in the concrete would approximate those contained in NUREG-1507.

Surface Activity Measurements

Measurements of total surface activity levels were primarily performed using gas proportional detectors with portable ratemeter-scalers. Surface activity measurements were performed on upper room surfaces, some equipment, and at locations of elevated direct radiation.

Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the total efficiency ($\epsilon_i \times \epsilon_s$) and correcting for the active area of the detector.

Average background count rates were obtained from the vestibule entry on the south side of the Building 707, for poured concrete construction material. The area was considered to have had no known radiological issues. Typical alpha activity background count rates for unpainted surfaces averaged 2 to 5 cpm for the gas proportional and dual phosphor detectors. The physical surface area assessed by the gas proportional detectors was 126 cm^2 and 100 cm^2 for the dual phosphor detector.

Removable Activity Measurements

Removable gross alpha and gross beta activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

ANALYTICAL PROCEDURES

Gross Alpha/Beta

Smears were counted for two minutes on a low-background gas proportional system for gross alpha and gross beta activity. The MDCs of the procedure were 9 dpm/100 cm^2 for gross alpha and 15 dpm/100 cm^2 for gross alpha and gross beta, respectively.

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65\sqrt{BKG})$]. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5 (DOE 1990)

BASIC DOSE LIMITS

The basic dose limit for the annual radiation (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

EXTERNAL GAMMA RADIATION

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

SURFACE CONTAMINATION GUIDELINES

Allowable Total Residual Surface Contamination

(dpm/100 cm^2)[a]

Radionuclides[b]	Average[c,d]	Maximum[d,e]	Removable[d,f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000	15,000	1,000

[a] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[c] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

[e] The maximum contamination level applies to an area of not more than 100 cm^2.

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

APPENDIX D

K-H QUALITY ASSURANCE SCAN SURVEYS FOLLOWING ORISE INDEPENDENT VERIFICATION OF BUILDING 707

APPENDIX D

QUALITY ASSURANCE SCAN SURVEYS FOLLOWING ORISE IV OF BUILDING 707

Executive Summary

Pursuant to discussions with DOE/RFPO, CDPHE, ORISE, and K-H representatives on November 29 and December 1, 2004, additional quality assurance (QA) surveys were conducted in Building 707. A written survey protocol was developed and approved by DOE/RFPO, ORISE, and CDPHE representatives. Based upon this protocol, five 707 survey units were selected for these additional QA surveys. Three Class 1 survey units were selected which ORISE did not survey as part of their validation studies. Two Class 2 survey units were selected in which ORISE performed validation surveys. Results of these additional surveys indicate that all five survey units meet the agreed upon survey criteria. All elevated areas were verified to be less than 100 dpm/100 cm^2 over the affected one square meter area in accordance with DOE Order 5400.5.

Initially, two of the chosen survey units did not meet the first 10 percent scan criteria. However, both of these units (707065B and 707096B) did meet the second 10 percent scan criteria. Two identified areas (one in each survey unit) have been remediated to <300 dpm/100 cm^2. The pre-remediated levels were 520 dpm/100 cm^2 and 535 dpm/100 cm^2.

Introduction/Scope

Additional quality assurance scan surveys have been performed in Building 707 based upon agreements among DOE/RFPO, CDPHE, ORISE, and K-H. These surveys were performed with oversight by K-H supervision, DOE/RFPO, and on-site MARSSIM experienced personnel. A total of five survey units were selected: Three Class 1 survey units which were not surveyed by ORISE; and two Class 2 survey units which were surveyed by ORISE. These units were selected based upon a bias toward higher potential for contamination due to historical activities in Building 707. This historical criteria resulted in survey units being selected in Modules A, B, E, and J, as shown in the following table.

Module	Survey Unit	Area Classification	Area Description
A	707021	2	walls, ceilings, columns
B	707030	2	walls, ceilings, columns
B	707031	1	floors
E	707065	1	floors
J	707096	1	floors

Letter designations were used behind the survey unit number in the survey data packages to indicate the number of 10 percent scans required for each unit. For example, both survey units 707065 and 707096 required a second 10 percent scan, therefore, two data packages exist for each of these two packages, i.e. 707065A and 707065B and likewise for 707096A and 707096B. Blue grids on the survey maps identify the first 10 percent scan grids for the "A" packages. Green grids on the survey maps identify the second 10 percent scan grids for the "B" packages. Scan grid maps were generated through a random grid process.

The following agreed upon protocol was utilized to perform the quality assurance surveys:

- Grid 10% of selected survey units
- Perform and document scans of areas
- Remediate all areas $\geq$300 dpm/100 cm^2
- If remediation is required, select and scan an additional 10% within same area
- Repeat until scan results indicate < 300 dpm/100 cm^2
- Complete all selected survey units
- Report all results to DOE/RFPO for transmittal to ORISE for review/comment

All survey measurements were performed using NE Electra instrumentation with DP-6 probes, which have a calculated minimum detectable activity of approximately 75 dpm/100 cm^2.

Radiological Survey Results

Survey Unit 707021A

This survey unit is comprised of the walls, columns, and ceiling in the "A" module area, on the first floor of Building 707. The walls and ceiling were part of the corridor, separated by drywall walls and a false ceiling, and not a part of "A" module. Therefore, it is classified as a Class 2 survey unit. The classification was based on the minimal potential for contamination due to process history. No contamination in excess of the unrestricted release limits was anticipated. 707021 was surveyed by ORISE during its independent verification surveys of Building 707.

Survey unit 707021A met the 10 percent scan criteria with the highest detected contamination level of 265 dpm/100 cm^2. No further action is necessary. Refer to attached data package for 707021A for radiological survey data, investigation documentation, survey map locations, data sheets, and instrument information.

Survey Unit 707030A

This survey unit is comprised of the walls, columns, and ceiling in the "B" module area, on the first floor of Building 707. The walls and ceiling were part of the corridor, separated by drywall walls and a false ceiling, and not a part of "B" module. Therefore, it is classified as a Class 2 survey unit. The classification was based on the minimal potential for contamination due to process history. 707030 was surveyed by ORISE during its independent verification surveys of Building 707.

Survey unit 707030A met the 10 percent scan criteria with the highest detected contamination level of 280 dpm/100 cm^2. No further action is necessary. Refer to attached data package for 707030A for radiological survey data, investigation documentation, survey map locations, data sheets, and instrument information.

Survey Unit 707031A

This survey unit is comprised of the floor surfaces between column lines C-D and 3-5 in the "B" module area, on the first floor of Building 707. It is classified as a Class 1 survey unit. The classification is based upon the higher potential for contamination due to process history. 707031 was not surveyed by ORISE during its independent verification surveys of Building 707.

Survey unit 707031A met the 10 percent scan criteria with the highest detected contamination level of 95 dpm/100 cm^2. No further action is necessary. Refer to attached data package for 707031A for radiological survey data, investigation documentation, survey map locations, data sheets, and instrument information.

Survey Unit 707065A

This survey unit is comprised of the floor surfaces between column lines K-L and 9-11 in the "E" module area, on the first floor of Building 707. It is classified as a Class 1 survey unit. The classification is based upon the higher potential for contamination due to process history. 707065 was not surveyed by ORISE during its independent verification surveys of Building 707.

Survey Unit 707065A did not meet the first 10 percent scan criteria. Survey grid #2 indicated one 100 cm^2 area of 520 dpm. Therefore, an additional 10 percent scan area was randomly generated, gridded, and surveyed. This new area was identified as Survey Unit 707065B and survey results indicate that this unit met the second 10 percent scan criteria. The highest contamination level detected in 707065B was 165 dpm/100 cm^2.

The area within survey unit 707065A of 520 dpm/100 cm^2 has been remediated to <300 dpm/100 cm^2.

Grid #4 in 707065A initially indicated several 100 cm^2 areas that would have averaged greater than 100 dpm/100 cm^2, without any one area greater than 300 dpm/100 cm^2. A resurvey confirmed all levels to be less than the 100 dpm/100 cm^2. Therefore, the initial elevated results were attributed to short-lived radon progeny. Refer to the Radon Investigation Information section of this report for general details.

Survey Unit 707096A

This survey unit is comprised of the floor surfaces between column lines O-Q and 1-3 in the "J" module area, on the first floor of Building 707. It is classified as a Class 1 survey unit. The classification is based upon the higher potential for contamination due to process history. 707096 was not surveyed by ORISE during its independent verification surveys of Building 707.

Survey Unit 707096A did not meet the first 10 percent scan criteria. Survey grid #23 indicated one 100 cm^2 area of 535 dpm. Therefore, an additional 10 percent scan area was randomly generated, gridded, and surveyed. This new area was identified as Survey Unit 707096B and survey results indicate that this unit met the second 10 percent scan criteria. The highest contamination level detected in 707096B was 275 dpm/100 cm^2.

The area within survey unit 707096A of 535 dpm/100 cm^2 has been remediated to <300 dpm/100 cm^2.

Radon Investigation Information

During these quality assurance surveys, radon interference was observed. A few survey grids initially indicated elevated levels ranging from approximately 500 to 700 dpm/100 cm^2. Follow-up surveys along with tape presses on the specific areas proved the radon interference. All final grid survey results documented on the data sheets are actual results without radon interference.

Disposition of ORISE Suspected Elevated Areas

Confusion may have occurred during the October 11-15, 2004 ORISE site verification activities regarding specific areas within Building 707 not meeting the free release criteria. For these areas, K-H planned to plate or otherwise control the building material as contaminated waste during building demolition. This became evident upon review of the ORISE survey data and the ORISE Interim Report Letter, dated November 24, 2004, to Mr. Gary Shuetz, (DOE/RFPO) from Phyllis Weaver (ORISE/ESSAP).

Even though several of the suspected elevated areas were identified by ORISE in their survey data reports with footnotes stating "location to be covered with steel plate and removed after building demolition," ORISE utilized these elevated survey results to indicate potential concerns with the K-H release survey protocol.

Please note, all of the areas in question were identified by K-H prior to the ORISE verification surveys to be plated, controlled and handling as contaminated waste during or after demolition. Two of the areas in question are large area depressions in the first floor of Building 707 and were filled with flow fill concrete as a special control measure which will be removed as part of the contaminated slab removal after demolition.

Miscommunication on the part of KH with the onsite ORISE survey personnel resulted in areas being misidentified as areas for free release instead of areas requiring appropriate controls for handling as contaminated waste during demolition.

An additional factor which resulted in confusion was that active remediation was being performed in some areas of Building 707 while ORISE was conducting independent verification surveys. This resulted in ORISE personnel surveying an area in which final remediation and/or K-H release surveys had not been completed. Most of these identified areas were remediated and validated by ORISE as meeting free release criteria prior to ORISE personnel leaving the site. DOE/RFPO and K-H personnel performed final verification for appropriate disposition of these areas through a visual inspection and walk-down on December 2, 2004.

The following table provides disposition of the ORISE reported suspected elevated area surveys. This table utilizes the initial ORISE measurements in dpm/100 cm^2. However, through discussions between DOE/RFPO and ORISE management, it is expected that ORISE will resolve the instrument calibration differences between the K-H and ORISE protocol (2π versus 4π calibration). This will result in ORISE measurement values reflecting the approval site pre-demolition survey plan protocol.

Suspected Elevated Area Disposition

Module	Survey Unit	ORISE Measurement Location	ORISE Measurement[1] (dpm/100 cm²)	Disposition Comments
J	707095	40D	1,400	Note 2 below
J	707095	41D	31,000	Note 2 below
K	707093	29E	1,000	Note 3 below
K	707093	30E	3,900	Note 3 below
K	707093	31E	1,700	Note 3 below
K	707093	32E	1,100	Note 3 below
F	707070	66	4,700	ORISE Validated KH remediation to 43 dpm /100cm²
F	707070	68	4,700	ORISE Validated KH remediation to 43 dpm /100cm²
A	707022	96C	1,900	ORISE Validated KH remediation to 94 dpm /100cm²
A	707022	97C	1,800	ORISE Validated KH remediation to 110 dpm /100cm²
A	707024	57C	1,100	ORISE Validated KH remediation to 220 dpm /100cm²
A	707024	58C	4,600	ORISE Validated KH remediation to 120 dpm /100cm²
A	707024	64C	2,600	ORISE Validated KH remediation to 120 dpm /100cm²
A	707027	68C	2,300	ORISE Validated KH remediation to 72 dpm /100cm²
A	707027	70C	12,000	Note 2 below
B	707030	83B	2,500	Note 2 below
B	707035	39C	9,500	Note 2 below
B	707035	40C	3,000	Note 2 below
B	707035	41C	1,400	ORISE Validated KH remediation to 79 dpm /100cm²
B	707036	47C	2,700	ORISE Validated KH remediation to 120 dpm /100cm²
D	707048	19A	1,500	ORISE Validated KH remediation to 72 dpm /100cm²
E	707062	36A	1,600	ORISE Validated KH remediation to 110 dpm /100cm²
E	707057	92B	3,800	Note 4 below
K	707098	44D	530	ORISE Validated KH remediation to 94 dpm /100cm²
K	707098	45D	800	ORISE Validated KH remediation to 94 dpm /100cm²
K	707098	46D	690	ORISE Validated KH remediation to 94 dpm /100cm²
J	707118	14E	1,100	ORISE Validated KH remediation to 120 dpm /100cm²
J	707118	17E	1,200	ORISE Validated KH remediation to 58 dpm /100cm²
J	707118	18E	2,300	ORISE Validated KH remediation to 100 dpm /100cm²

Notes:

1. ORISE expected to revise initially reported measurement values.
2. Area plated to be removed after building demolition as LLW.
3. Area remediated to <300 dpm/100 cm².
4. Area identified for removal during demolition (structural steel).

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

November 30, 2005

Mr. Ron Bostic
Rocky Flats Project Office
U.S. Department of Energy
10808 Hwy 93, Unit A
Golden, CO 80403

SUBJECT: CONTRACT NO. DE-ACO5-00OR22750
FINAL REPORT—IN-PROCESS VERIFICATION SURVEY FOR THE BUILDING 771 AND 774 CLOSURE PROJECT, ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN, COLORADO

Dear Mr. Bostic:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has prepared the final report for the Building 771 and 774 Closure Project at the Rocky Flats Environmental Technology Site in Golden, Colorado. Comments provided on the draft report have been incorporated into the final report.

Please contact me at (865) 576-5321 or Scott Kirk at (865) 574-0685 should you need additional information.

Sincerely,

Phyllis C. Weaver
Health Physics/Project Leader
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The Oak Ridge Institute for Science and Education (ORISE) is a U.S. Department of Energy facility focusing on scientific initiatives to research health risks from occupational hazards, assess environmental cleanup, respond to radiation medical emergencies, support national security and emergency preparedness, and educate the next generation of scientists. ORISE is managed by Oak Ridge Associated Universities. Established in 1946, ORAU is a consortium of 91 colleges and universities.

IN-PROCESS VERIFICATION SURVEY
FOR THE
BUILDING 771 AND 774 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Prepared by

Phyllis C. Weaver

Environmental Survey and Site Assessment Program
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Prepared for the

Department of Energy

FINAL REPORT

NOVEMBER 2005

This report is based on work performed under contract number DE-AC05-00OR22750 with the U.S. Department of Energy.

IN-PROCESS VERIFICATION SURVEY
FOR THE
BUILDING 771 AND 774 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

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ABBREVIATIONS AND ACRONYMS

b_i	background counts in observation interval
ε_i	instrument efficiency
ε_s	source efficiency
ε_{Total}	total efficiency
BKG	background
Ci	curie
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
dpm	disintegrations per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DOP	Decommissioning Operations Plan
DQOs	data quality objectives
DTPA	diethylenetriaminepentaacetic acid
EDTA	ethylenediaminetetraacetic acid
ESH	Environmental, Safety, and Health
ESSAP	Environmental Survey and Site Assessment Program
FIDLER	Field Instrument for the Detection of Low-Energy Radiation
FSS	final status survey
GM	Gieger-Muller
K-H	Kaiser Hill
KeV	Kilo electron Volt
IDEC	Indirect/Direct Envaporation Cooling Area
ITP	Intercomparison Testing Program
IV	independent verification
IVPP	independent verification program plan
IVT	independent verification team
m	meter
mg	milligram
m^2	square meter
mm	millimeter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MeV	million electron volts
n	number of data points
nCi/g	nanocuries per gram
NaI	sodium iodide
NIST	National Institute of Standards and Technology

ABBREVIATIONS AND ACRONYMS (Continued)

NRC	Nuclear Regulatory Commission
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PDS	pre-demolition survey
PDSR	pre-demolition survey report
RFETS	Rocky Flats Environmental Technology Site
RFPO	Rocky Flats Project Office
s	seconds
SU	survey unit
TAP	total absorption peak
TSA	total surface activity
ZnS	zinc sulfide

IN-PROCESS VERIFICATION
OF THE
BUILDINGS 771 AND 774 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

INTRODUCTION AND SITE HISTORY

The Atomic Energy Commission, predecessor agency to the U.S. Department of Energy (DOE), selected the Rocky Flats site in 1951 to serve as a nuclear weapons component production facility. Production began in 1952 on both nuclear and non-nuclear components with the plutonium pits being the key component. Uranium and beryllium were also utilized in the production of various components and processes. Operations continued until 1989 when environmental and safety concerns temporarily halted operations. There were over 700 structures such as process and support buildings that were involved in the site's mission. In 1993, the production mission was permanently ended and a new mission to clean up the site by 2006 was initiated. The site has since been renamed as the Rocky Flats Environmental Technology Site (RFETS).

Kaiser-Hill Company, L.L.C. (K-H), is the DOE contractor responsible for closure of the RFETS by the year 2006. To meet the closure goal K-H characterized, remediated, performed surveys, demolished and disposed of each building at the site as either clean or radiologically contaminated wastes.

Demolition and disposal has been completed by K-H for the Building 771 and 774 Closure Project. Buildings 771 and 774 were among four major process buildings constructed in the early 1950's. The two structures were connected, via Building 771C that housed the former drum counting and storage facility (K-H 2001a).

Building 771 served as the primary facility for plutonium operations from 1953 until 1989 when operations were shut down. Building 771 housed five major operational groups: (1) Plutonium Recovery which recovered plutonium from a variety of processed residues, (2) Plutonium Special Recovery that processed scrap metal and oxide residues, (3) Plutonium Chemistry Research and Development that supported methods for recovering, separating, and purifying actinides, (4) Plutonium Metallurgy Research group that assisted with design and plant production in the development of weapons machining and fabrication, and (5) Analytical Laboratories that prepared and analyzed liquid and solid samples of various isotopes as well as plutonium. For historical context, a major glovebox fire occurred in 1957 resulting in significant contamination, such that the plutonium foundry and fabrication and assembly operations previously located in this facility were moved to Building 776/777 (K-H 2001a).

Building 774 was constructed in 1953 and later connected to Building 771 in 1962 by a concrete utility and pipe-chase tunnel. Processed liquid radioactive and hazardous wastes that originated from a variety of building operations were transferred to Building 774 via underground waste transfer lines through the tunnel, 55-gallon drums, or in plastic bottles. These waste streams may have also contained contaminants other than plutonium such as uranium, americium, and other transuranics. Additional support facilities were later constructed and adjoined Building 774 to accommodate the waste volume and new treatment processes (K-H 2001a and b, 2003a).

The DOE's Rocky Flats Project Office (RFPO) requested that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) provide Type B independent verification (IV) of Building 771 and Type A independent verification of Building 774.

SITE DESCRIPTION

The RFETS is located approximately 16 miles northwest of Denver, Colorado on State Highway 93 and Cactus Road. RFETS occupies approximately 385 acres within the 6,000 acre reservation site owned by DOE. There were approximately 700 buildings and structures on the site, most of which were associated with the production of nuclear weapons (Figure 1). The site was divided into two major operable units, the DOE Retained Area and the Site Refuge Area. All nuclear facilities at the site are within the boundaries of the Industrial Area (ORISE 2004a).

Buildings 771 and 774 were located in the north-central section of the RFETS Industrial Area (Figure 2). Buildings 771 and 774 were constructed of steel-reinforced concrete having interior walls of concrete block or cinderblock, either unfinished or finished with Gypsum™ or

Transite™ paneled walls. Ceilings and floors were poured steel-reinforced concrete covered with an epoxy paint finish for ease of decontamination during operations (K-H 2001a).

Building 771 was a two-story structure built into a hillside with only the north side primarily exposed. Plot plans for the first and second floors, as each existed during the verification surveys in Building 771, are shown in Figures 3 and 4. Building 771 had six major additions that expanded the original facility area from 131,000 square feet to approximately 151,000 square feet. Tunnels used for utilities and the transfer of materials from Building 771 were connected to Buildings 774 and 776 (K-H 2001a).

Building 774 was also a two story structure which contained a large variety of above and below ground concrete and steel tanks for storing liquids (Figure 2). Seven additions were eventually constructed to the original 60 by 60-foot structure. During operation, Building 774 was divided in half to treat the various types of waste. High-level alpha activity wastes were treated in the west half of the building and low-level wastes were treated in the eastern half. The dividing wall separating this building was constructed of reinforced concrete (K-H 2001b).

Building 774 was demolished after ESSAP reviewed the Pre-Demolition Survey Reports (PDSR) for the North Dock Area and the 1973 addition (K-H 2003a and 2004a). Upon the completion of Type B surveys, Building 771 was demolished. Portions of the Building 771 structure greater than six feet below final grade remain as established in the approved closure project characterization plan (K-H 2003b).

INDEPENDENT VERIFICATION OBJECTIVES

Independent verification of Building 771 was implemented to evaluate the data quality objectives (DQOs), as defined in the independent verification program plan (IVPP), prior to pre-demolition of Building 771 (ORISE 2004a). The decommissioning approach implemented by K-H was evaluated by the IVT. Results from document reviews and data collection were compared to specified guideline criteria as stated in the approved project characterization plan and pre-demolition survey plan (K-H 2003a and 2002). The IVT collected media and core samples, performed surface scans for low-energy gamma and alpha radiation, performed Total Surface Activity (TSA) measurements, and collected smear samples for removable activity.

The IVT utilized MARSSIM's guiding principles to conduct verification activities in an expeditious manner to assess the Decontamination and Decommissioning (D&D) contractor's process. The IVT implemented the in-process inspection as outlined in the IVPP for areas not physically evaluated to assess the contractor's effort through significant documentation and procedure implementation. This included reviewing the methodology used to classify areas according to contamination potential. As such, procedures for the selection, calibration and use of survey instrumentation, as well as the adequacy of survey procedures and analytical planning were assessed. Review activities were also focused on procedures that the IVT had not evaluated during verifications of other RFETS closure projects (ORISE 2004a).

DOCUMENT REVIEW

The IVT performed document reviews and provided comments, where necessary, on the contractor's Pre-demolition Survey (PDS) Plans, guidelines document, supporting data and related reports, and historical assessment documentation (K-H 2001a/b, 2002, 2003a/b, and 2004b through g). Type A verifications were performed for seven SUs located in the North Dock Area of Building 774 (i.e., SU 771048, 771054, 771056, 771057, 771058, 771046, and 771102) and the 1973 addition to Building 774 (K-H 2003a and 2004a). Type A reviews were completed for several areas in Building 771, the Administration Building (West), Locker Room Area, and the Indirect/Direct Evaporative Cooling Building (K-H 2004b, c, and d). The reviews resulted in generating comments concerning inconsistencies in the presentation of the data, specifically concerning documentation for survey methodology and survey results. Initial reviews of these data sources identified a concern associated with implementation of MARSSIM guidance protocol (i.e., classification or re-classification of SUs).

The PSDR for Building 771 was reviewed for implementation of the sampling and measurement processes and to assess the overall final results of the remediation effort. Documentation reviewed by the IVT indicated that a significant amount of decommissioning-related work had been accomplished by K-H to reduce remaining contamination levels to within the permissible guidelines (K-H 2004f and g).

RADIOLOGICAL SURVEY PROCEDURES

Survey activities were conducted by the IVT in accordance with a project-specific plan and supplemented by the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2004b, c, and d). The IVT conducted scans for alpha and low-energy gamma activity and TSA measurements, and collected smears for removable activity, core and media samples in Building 771 during the periods of July 27 through August 2 and August 19 through August 26, 2004. Surface activity measurements were obtained to transform the existing surface activity measurements into concentration-based units needed to allow a comparison against the established release criteria as specified in the characterization reports and PDS Plan (K-H 2001b and 2002). Instrumentation included a field instrument used for the detection of low-energy radiation (FIDLER), gas proportional dual phosphor detectors, and zinc sulfide (ZnS) scintillation detectors each coupled to ratemeter-scales with audible output.

The initial verification survey activities were performed on structural surfaces greater than six feet below final grade (survey areas AE and AF). In-process remediation, survey activities, and demolition were being conducted by K-H upon arrival of the IVT in July 2004. The subsequent survey efforts evaluated SUs on the second floor (Area AH within six feet of final grade) and the first floor ceiling (Areas AE and AF). The locations on the first floor that were assessed by the IVT included SUs 771072, 771073, 771074, 771075. In addition, the IVT conducted radiological surveys of SUs 771038, 771039, 771040, 771041, 771043, 771044, and 771076 that were located on the second floor. Data collected were compared to the surface guideline criteria for unrestricted release in accordance with DOE Order 5400.5 (DOE 1993 and 1995).

In addition to the surface measurements, environmental media which included concrete cores and surface concrete from the floor slab were collected in survey areas AE and AF for surfaces greater than six feet below final grade to determine whether or not the volumetric release criteria specified in the approved Decommissioning Operation Plan (DOP) had been met. In addition, this sampling effort also provided the technical basis for using surface gamma measurements as a surrogate to estimate the concentration of Pu-239 contamination present. Accordingly, surface media collected at randomly generated locations and core samples collected at locations with elevated surface radioactivity levels were assessed using this surrogate measurement approach as the basis for determining if the approved D&D objectives had been achieved.

REFERENCE GRID

The IVT used the remaining SU reference system established by the D&D contractor to identify measurement and sampling locations. Measurement and sampling locations were documented on available survey maps.

SURFACE SCANS

Alpha surface scans were performed using instrumentation based on the best available technology for the type of contamination. Scans were performed in over 75 percent of accessible areas in Class 1 SUs and approximately 10 to 40 percent in Class 2 SUs. Scans for alpha activity were focused on areas such as walls and overhead surfaces including ledges, support beams, and penetrations. Alpha surface scans of the floors were performed using a large area gas proportional detector in SUs designated for fill release. Gas proportional detectors or dual phosphor scintillation detectors coupled to ratemeter-scalers were used to identify locations with elevated direct radiation readings. These locations were identified and marked for further investigation. In addition, ESSAP performed surface activity scans using the FIDLER detector on at least 70 percent of the available floor area in SUs 771072, 771073, 771074, and 771075 (Areas AE and AF).

The floor had been covered in an epoxy encapsulant prior to ESSAP's arrival. Scans identified numerous locations in excess of the field action level of 250,000 cpm (established by K-H) that necessitated further investigations. As such, these additional investigations were conducted on a case-by-case basis at locations exceeding the field action level; investigations included additional surface measurements and/or sampling.

Fifty to 70 percent of the available floor surfaces located in SUs 771038, 771039, 771040, 771041, 771043, 771044, and 771076 of Area AH were selected for scanning. Approximately 20 percent of the lower wall area and 10 percent of the upper wall and ceiling surfaces in survey areas AE and AF on the first floor were scanned with either a hand-held gas proportional or plastic scintillation detector. These same types of survey instruments were also used to conduct surveys on the second floor in SUs 771039, 771041, and 771043. All detectors were coupled to ratemeter-scalers with audible indicators to more effectively locate areas suspected of containing elevated levels of radioactivity.

Numerous locations were identified through surface scans which were greater than the gamma surface action level, but all were not sampled. The IVT identified and marked locations of high residual radioactivity and identified these locations to K-H and DOE.

Particular attention was given to cracks and joints in the floor, walls, and ceilings, and on ledges or other horizontal surfaces. Overhead and upper surface scans focused on areas such as ledges, support beams, and around penetrations or other openings through the ceiling. Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B.

SURFACE ACTIVITY MEASUREMENTS

The IVT obtained alpha TSA measurements on the floor, lower wall, and ceiling locations from the first and second floor SUs designated as areas suitable for free release. Measurement locations were selected by various methods that included locations specified by DOE, randomly generated locations, and judgmental locations identified during scanning. Alpha surface activity measurements were collected at 147 locations using gas proportional and plastic scintillation detectors coupled to ratemeter-scalers (Figures 6-14). In addition, alpha surface activity measurements were collected on the ceiling of Areas AE and AF (Figures 6 and 7) at 31 individual locations. Smear samples were also collected to determine the levels of removable activity at each of the direct alpha measurement locations.

Gamma surface activity measurements were performed to determine if the remaining building floor slab (at greater than six feet below final finish grade) would meet the surficial radionuclide concentration criteria. Fifty measurements were obtained in survey areas AE and AF on the floor at locations that were identified to be greater than the field action level (Figure 5). The surfaces in survey areas AE and AF had been coated with the latex fixative. All gamma measurements were performed on contact with the floor surface using the FIDLER.

MISCELLANEOUS SAMPLING

The IVT collected 15 surface media samples from randomly generated locations in survey areas AE and 14 samples from survey area AF (Figure 15). However, ESSAP did not accept the 14 media samples from area AF due to suspected high concentrations of transuranics in the samples. Occasionally, the location of a randomly generated measurement location would be adjusted to capture a previously selected judgmental sampling location. Ten concrete core samples were also collected at selected judgmental locations within areas AE and AF (Figure 15).

SAMPLE ANALYSIS AND DATA INTERPRETATION

Radiological samples and data were returned to the ORISE/ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 2004e). Radiological data were compared to K-H results and the established criteria for the appropriate areas of concern.

Alpha TSA measurements and smear samples (analyzed for gross alpha and beta radioactivity using a low-background gas proportional counter) were collected and converted from counts per minute to units of disintegrations per minute per one hundred square centimeters (dpm/100 cm^2). Conversions into these units of measurements were needed to determine whether or not the surficial release criteria had been met.

A discrepancy that was identified early in the project noted that ORISE uses as standard practice a 2-π calibration for surface contamination instruments in accordance with ISO-7503 guidance (i.e., ORISE calibration considers surface efficiency and also results in a 4-π total efficiency), whereas K-H performed a 4-π calibration. Therefore, it became readily apparent that the reported ORISE alpha surface contamination results were nearly twice the reported activities of the K-H data for the same survey locations. Considering these differences, adjustments were made for evaluating the measurements reported by K-H and for accurately comparing the IVT's surface measurements against the approved release criteria.

Gamma surface activity measurements were also used to estimate the concentration of isotopic plutonium based on the observed Am-241 to Pu-239 ratio of 1:8. Gamma surface activity measurements were converted to units of nanocuries per gram (nCi/g) based on the calculation approach adapted from K-H and verified by ESSAP (K-H 2005).
Miscellaneous media and core samples were analyzed by gamma spectroscopy and reported in units of picocuries per gram (pCi/g). However, not all of the samples collected were shipped to the ESSAP laboratory for analysis since the concentration of radioactivity contained in some of the samples exceeded ESSAP's laboratory restrictions on total transuranic activity. Considerations for special handling of the cores and media samples were required because of the significant levels of radioactivity present, and therefore, only a limited quantity of material could be received at any given time to avoid any cross-contamination of the environmental laboratory facility.

Cores and media samples were analyzed by gamma spectroscopy and selected samples were analyzed by alpha spectroscopy because of the significant activity and the potential for significant radionuclide concentration. Spectra were reviewed for the presence of Am-241 since this information was needed to estimate the Pu-239 concentration from the levels of Am-241 measured by ESSAP's laboratory.

Additional information concerning major instrumentation, sampling equipment, calculation variables, and analytical procedures is provided in Appendices A and B.

RELEASE CRITERIA

The radionuclide of concern for the Building 771 Closure Project is 35 year old weapons grade plutonium (Pu-239/240). Portions of the Building 771 slab and areas below six feet of the final soil grade may remain in place as stated in the closure project characterization plan (K-H 2003b). The portions of the building six feet above the final grade must meet the requirements for unrestricted release of items, materials, equipment, and buildings prior to demolition or use as fill.

250

The applicable surface activity guidelines for plutonium from DOE Order 5400.5, Appendix C are (DOE 1993 and 1995):

Total Alpha Activity

100 α dpm/100 cm^2, averaged over a 1 m^2 area

300 α dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

20 α dpm/100 cm^2

The applicable building-specific criteria for the slab and structure below six feet of the final proposed grade (as stated in the DOP) is a concentration of 100 nCi/g (surface) and 7 nCi/g when averaged over the entire volume of concrete (K-H 2003b). For direct comparison to these applicable release limits, gamma surface activity measurements were converted to the appropriate concentration-based units as previously discussed.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP reviewed the PDSR documentation for Type A assessments for the North Dock Area and the 1973 Addition to Building 774, and the Indirect/Direct Evaporative Cooling (IDEC) area of Building 771 as part of the closure process for the 771/774 complex. A letter report for each PDSR was subsequently prepared for DOE (ORISE 2004f and g). Conclusions cited in the PDSR indicated that the criteria for free release had been met. However, ESSAP's independent reviews of the PDSR revealed that the guidelines at two locations at the Indirect/Direct Evaporative Cooling (IDEC) area were exceeded by 50%. The IDEC was initially considered a Class 3 SU. However, based on MARSSIM recommendations, Class 3 SUs that contain radioactivity exceeding 50% of the DCGL should be reclassified as Class 2 SUs, and thus, warrant more extensive field investigations to support suitable conclusions.

ESSAP reviewed a number of documents prepared by K-H in the development of the survey approach for evaluating Building 771 (K-H 2001a, 2002, and 2003b). The independent survey was designed based upon the available data indicating where the potential for contamination could be present at elevated levels.

At the time of the independent verification surveys, final survey data were not available for review. In addition, interim reports/data subsequently provided to ESSAP did not identify any areas where contamination existed at levels exceeding the release criteria. However, the results of actual survey data collected by ESSAP did not corroborate K-H findings contained in the interim reports, but instead indicated the presence of contamination at levels exceeding the established guidelines for free release and for structures that would be allowed to remain six feet below grade.

Since these findings were reported by ESSAP to DOE, K-H has prepared final reports for Building 771 that indicate all areas have been decontaminated to levels commensurate with the established guidelines. It should also be noted that many areas of Building 771 within six feet of final grade were removed and packaged as low-level radioactive waste during demolition.

SURFACE SCANS

Alpha surface scans of the ceiling on the first floor identified a small area that was flagged for additional investigation. Alpha scans of the above-grade surfaces on the second floor identified several areas of radioactivity above the surface criteria in each of the SUs investigated by ESSAP. Scans of the floor identified alpha activity ranging from 0 to 800 cpm, with the highest activity identified in SU 771039.

Gamma surface activity scans of areas AE and AF on the first floor ranged from 2,500 cpm to 640,000 cpm. Scans identified numerous locations in both SUs having levels of surface radioactivity exceeding the action level of 250,000 cpm, with the highest readings detected in Area AF. Gamma scan activity of second floor SUs ranged from 4,000 to 270,000 cpm.

Surface Activity Levels

A summary of ranges for total and removable alpha activity measurements is provided in Table 2. Of the 147 total surface activity (TSA) measurements collected, 43 locations were identified as having contamination in excess of the release criteria (i.e., 29 on the floor and 14 on the walls/ceiling). One TSA measurement from the ceiling in Area AF exceeded the maximum release guideline criteria for surfaces within six feet of final grade. Results of these TSA measurements ranged from -14 to 13,000 dpm/100 cm^2 with the highest activity identified in SU 771041. The greatest numbers of measurements exceeding the free release criteria were identified in SU 771038, 771039, 771041 and 771076.

Removable surface activity ranged from 0 to 35 dpm/100 cm^2. Two measurements collected at SU 771039 and 771041 yielded results of 31 and 35 dpm/100 cm^2, respectively that exceeded the removable alpha contamination criteria of 20 dpm/100 cm^2. Tables 3 to 11 provide specific information about the SU locations and measurement results obtained by the IVT.

Gamma surface activity measurements are presented in Table 1. Results of these measurements ranged from 250,000 to 690,000 which are approximately equivalent to 56 and 150 nCi/g, respectively. Nine of the fifty measurements obtained exceeded 100 nCi/g, with concentrations ranging from 110 to 150 nCi/g.

Radionuclide Concentration In Media And Core Samples

The results for surface media samples collected from the concrete floors of Area AE are presented in Table 12. All sample results were less than the 100 nCi/g concentration-based action level. These concentrations ranged from 0.0 to 43 nCi/g.

Five of the ten core samples collected were analyzed by ESSAP. All of the cores analyzed came from area AE where the activity was determined to be the highest. A case narrative was prepared describing the analytical process used to determine the radionuclide concentration in the core samples (ORISE 2004i). The narrative provided in Appendix E, outlines the investigation of Am-241 concentrations in each of the core samples. Initial investigation involved non-destructive assay of the cores, rotating the samples equal-distance for each counting interval using two different methodologies. Samples were then crushed, blended, and an aliquot of the blended sample measured (ORISE 2004i). Concentrations ranged from 2.0 nCi/g to 1,200 nCi/g. The highest sample was located near column E5 in area AE (Figure 15 and Table 12).

COMPARISON OF RESULTS WITH GUIDELINES

Survey results were compared with DOE approved site-specific guidelines for the free release of materials and for areas greater than six feet below final grade. The radionuclide of concern was weapons grade Pu-239 that had aged 35 years. The below final grade guideline criteria applied to floor and lower wall surfaces on the first floor of Building 771. Gamma scans of the floor identified numerous locations exceeding the field action level. Several locations were removed and disposed of as radioactive wastes while ESSAP was present at the site. Gamma scan activity ranged from 2,000 cpm to nearly 700,000 cpm.

Static gamma measurements were collected at 50 locations greater than the field action limit of 250,000 cpm. Nine of these locations exceeded the surficial criteria for surfaces greater than six feet below final grade when converted from cpm to nCi/g (Table 1). The Pu-239 concentration for the highest of the nine locations (Sample location #39) was estimated at 150 nCi/g (Figure 5).

All media and core samples were not analyzed because of the limitations on the quantity of activity allowed in the ESSAP laboratory facility. Analysis of five concrete core samples identified two that exceeded the volumetric guideline criteria of 7 nCi/g. The radionuclide concentrations in core samples from locations 001 and 003 were 13 nCi/g and 1,200 nCi/g, respectively. These two locations were remediated and verified to be less than 250,000 cpm by DOE.

Total surface activity measurements were taken on those surfaces that were above the final grade and could be free released. The results identified 42 measurements that were above the release criteria. The measurement location with the highest activity was identified in SU 771041 at location 70A (lower column). The activity of the 42 locations ranged from 340 to 13,000 dpm/100 cm^2. Based upon these results, five of the SUs selected for verification exceeded the 300 α dpm/100 cm^2 release criteria.

INTERIM FINDINGS AND RECOMMENDATIONS

During the initial survey efforts by ESSAP in Area AE, a large number of locations in excess of the field action level of 250,000 cpm were identified. To accommodate the accelerated path to complete work in the building, recommendations were proposed to DOE and K-H that those areas of elevated activity that were flagged could be further decontaminated, removed, or reassessed to verify that areas were less than the 100 nCi/g limit for surface concentration based on the collection of additional environmental data. Of these options, K-H elected to remove contamination at a number of locations during the verification effort. Collection of additional environmental data/measurements was also performed to provide better evidence as to the true nature and extent of contamination present in surface concrete. Further technical assessment of surface gamma measurements, based on the analytical results of core samples, determined that the 250,000 cpm action level was a conservative application of the 100 nCi/g.

The verification effort of SUs on the second floor of the building identified elevated total alpha surface activity well above the maximum alpha guideline criteria of 300 dpm/100 cm^2. Because of building completion scheduling, ESSAP recommended that additional investigation surveys be performed to identify a more effective path forward. The vast majority of activity in excess of the guidelines was identified on the floor surfaces. ESSAP recommended that follow-up surveys be concentrated in these areas. There was some indication during the independent verification that the identified areas of elevated activity were removable (either by tape press or vacuuming), which was an important factor for consideration when developing a follow-up action plan.

FOLLOW-UP ACTIONS

The first floor (Area AF) floor was re-scanned (100%) with the FIDLER due to the number of elevated results identified by ESSAP. Additional measurements were collected within the contiguous square meter at six locations that were identified to be in excess of 250,000 cpm to verify that the average activity over the square meter was less than 250,000 cpm. The square-meter averages at all six locations were confirmed to be less than 250,000 cpm, and therefore, no additional follow-up actions were needed.

In-situ gamma-spectroscopy surveys were also performed at two other areas of elevated activity (411,000 cpm and 500,000 cpm) to confirm that the actual surface concentration was less than 100 nCi/g. The results of measurements taken at these two locations were 53 nCi/g and 30 nCi/g.

Finally, as a best management practice, any areas of elevated activity (i.e., greater than 250,000 cpm) were remediated by surface scraping or saw cutting. This practice was highly successful in reducing the quantity of radioactivity to permissible levels.

The contractor took several steps to resolve the issues identified by ESSAP during the independent verification that were impeding the progress of successfully decommissioning the RFETS. Surveys were performed at the areas of elevated removable activity identified by ESSAP. The areas were then vacuumed by K-H and resurveyed to confirm the elevated activity had been removed. This proactive application proved successful for all areas of elevated activity.

Based on these results, the contractor recognized that the isolation controls previously established to prevent the spread of contamination from "hot" areas of the building to areas that had been surveyed for unrestricted release were not well marked, understood, or enforced. Specifically, workers and equipment were moving through areas of identified fixed contamination into areas previously surveyed. This lack of isolation control of the areas resulted in the spread of contamination into "clean" areas after the completion of the final status survey. The fact that the vast majority of the "hot-spots" were identified on the floor surfaces further corroborated this finding.

As follow-up actions needed to institute improved isolation controls, K-H implemented several corrective actions. The isolation boundaries around the areas of fixed contamination were greatly enhanced and the level of traffic on the second floor was greatly reduced. All portions of the second floor required to meet the surface contamination limits were vacuumed as this method had been proven to be highly effective at removing these newly deposited hot-spots.

Lastly, to verify that the combination of enhanced isolation controls and vacuuming were effective, a quality assurance survey of an approximate 100 m^2 area was performed around the stairwell opening near the west wall. The survey was intentionally biased to this location as it falls in the path of the heaviest foot traffic and is downwind of the large area of fixed contamination. The results of this quality assurance survey demonstrated that the contamination levels in this area were compliant with the surface contamination limits to support this important decommissioning project.

CONCLUSION

A team with the Environmental Survey and Site Assessment Program (ESSAP) conducted in-process verification surveys in Building 771 during the periods between July 27 through August 2 and August 19 through August 26, 2004. ESSAP was notified by the U.S. Department of Energy that Kaiser Hill Company, L.L.C had completed the pre-demolition phase of Class 1 and Class 2 areas and was ready for verification. ESSAP also performed in-process surveys of the first-floor survey areas that were specified to remain at greater than six feet below final grade (as specified in the DOP). Based on the follow-up actions performed by the contactor to resolve the issues identified by ESSAP during verification efforts, the Building 771 structure meets the applicable guideline criteria, with the exception of the areas that were identified to be removed and packaged as radiological waste.

FIGURES

967-017 (1)

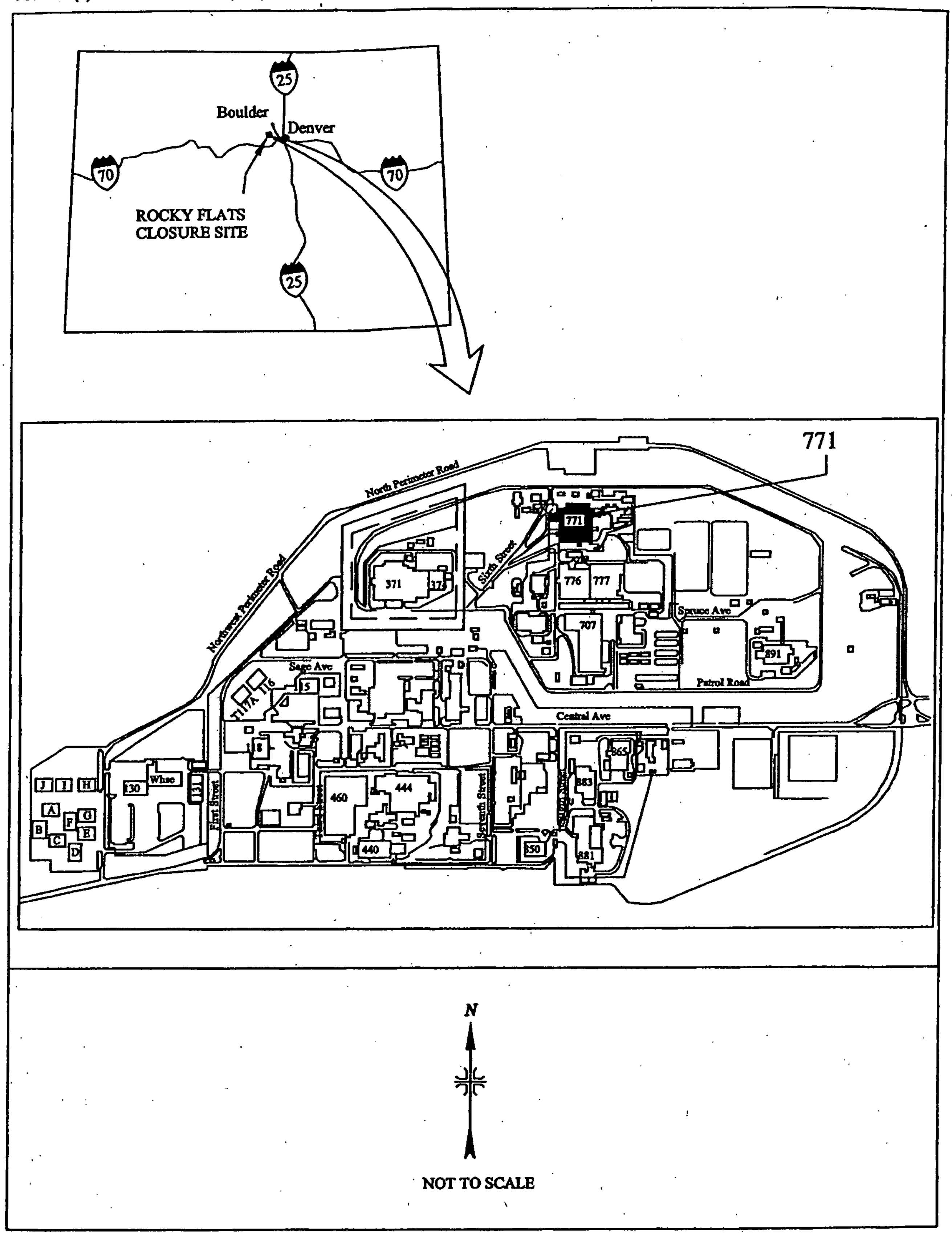


FIGURE 1: Location of the Rocky Flats Closure Site

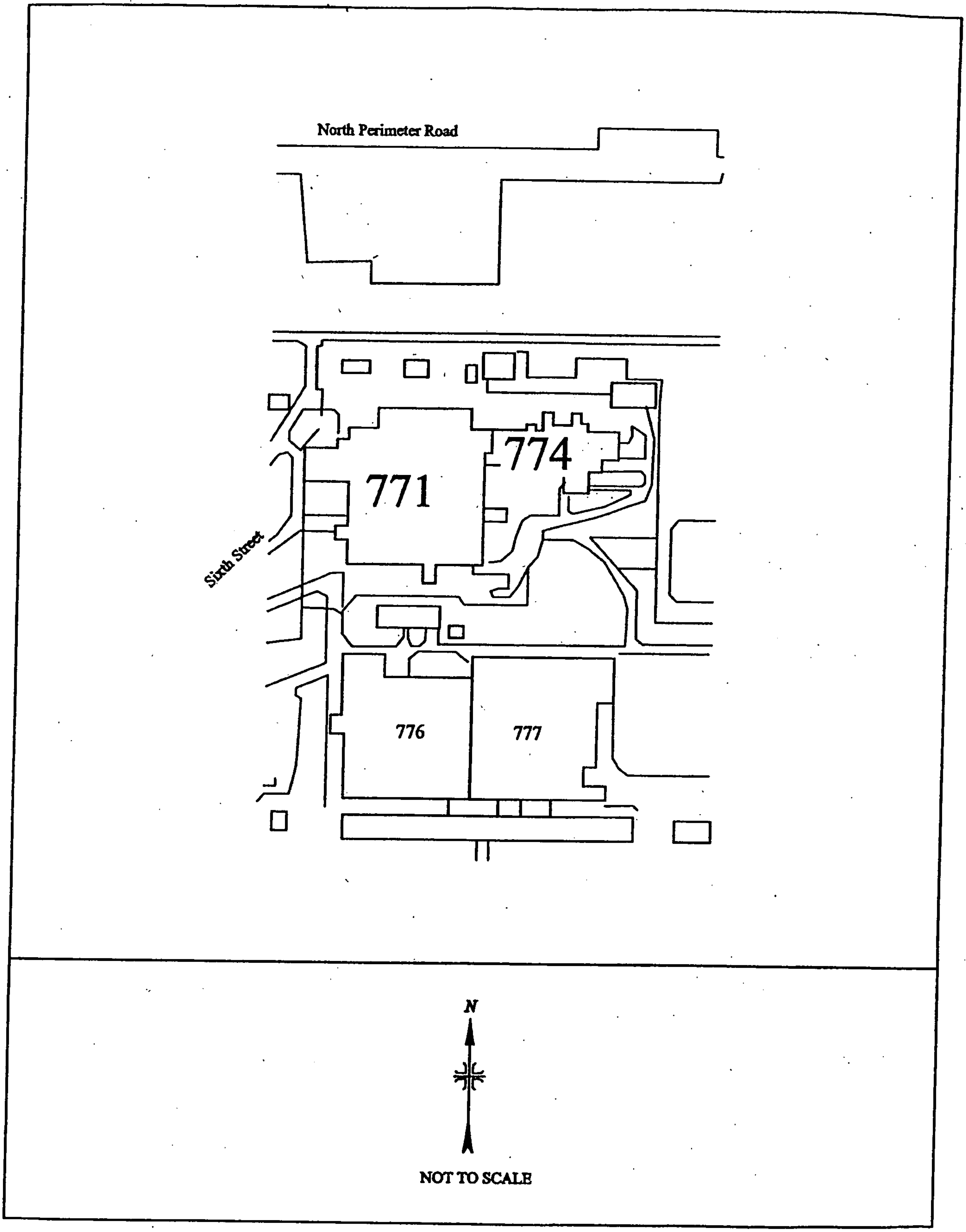


FIGURE 2: Location of Building 771 and 774

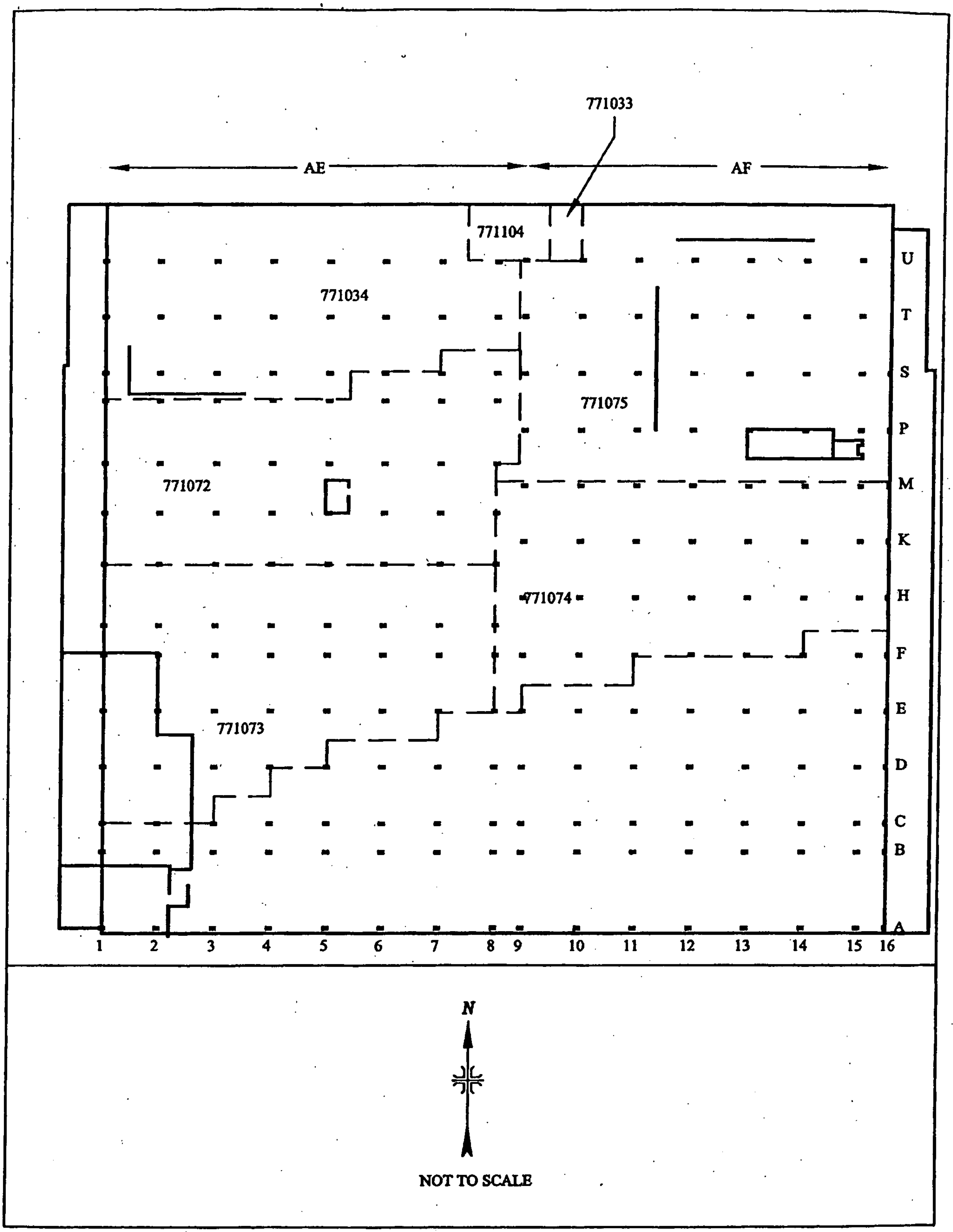


FIGURE 3: Building 771, First Floor - Plot Plan

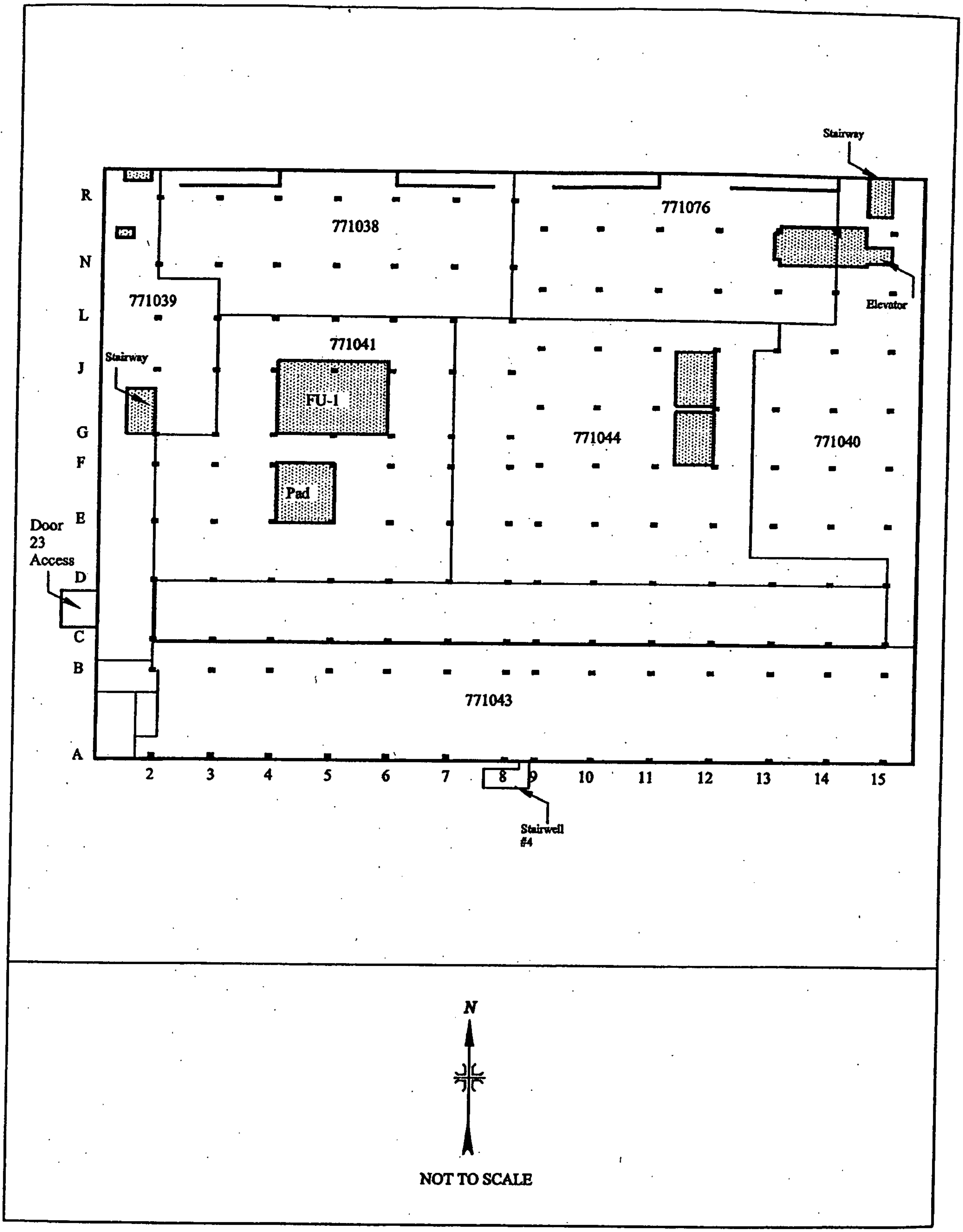


FIGURE 4: Building 771, Second Floor - Plot Plan

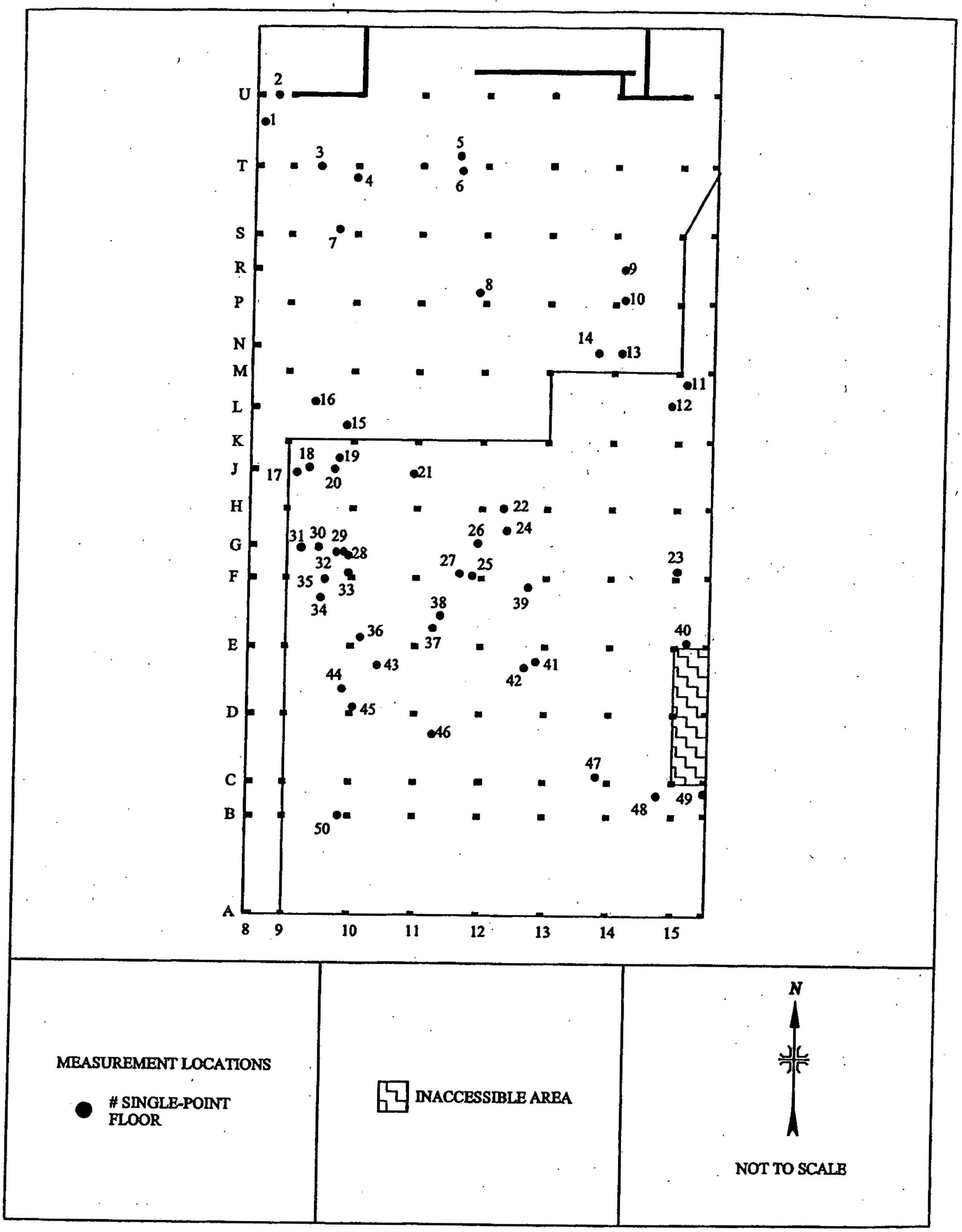


FIGURE 5: Building 771, First Floor, Areas AE and AF- Judgmental Gamma Activity Measurement Locations

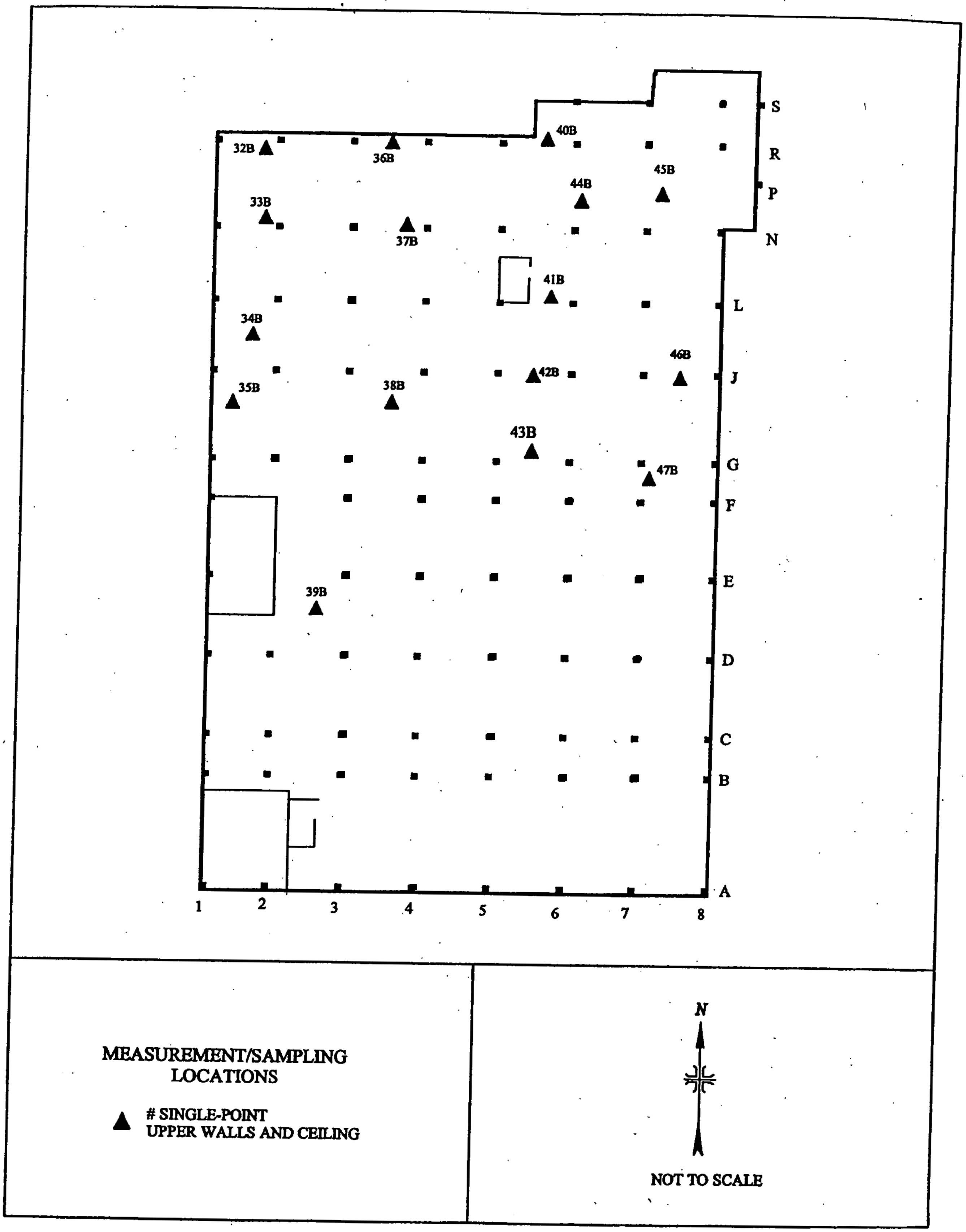


FIGURE 6: Building 771, First Floor, Area AE (Upper Walls and Ceiling) Measurement Locations

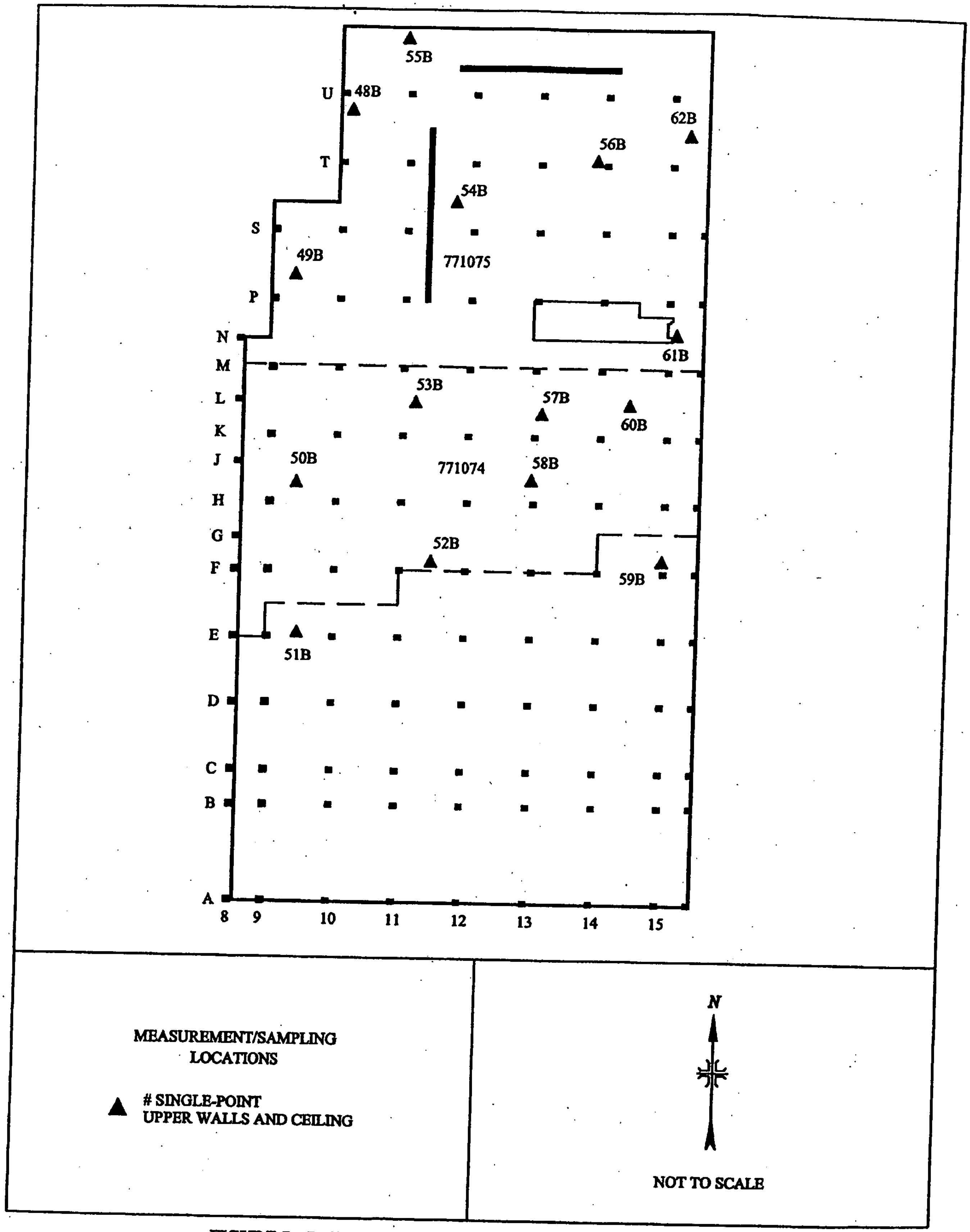


FIGURE 7: Building 771, First Floor, Area AF (Upper Walls and Ceiling) Measurement Locations

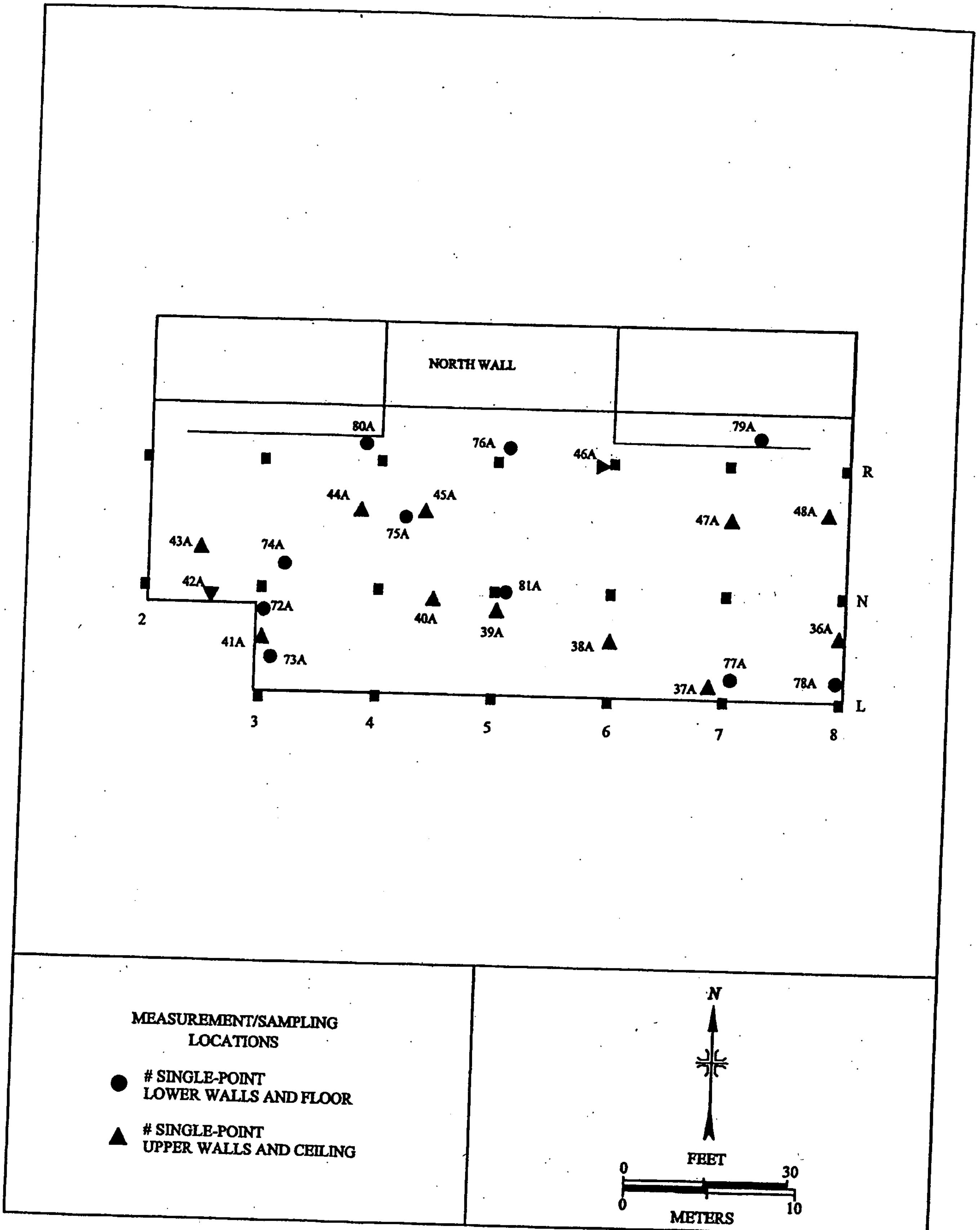


FIGURE 8: Building 771, Second Floor, Survey Unit-771038, Area AH - Measurement and Sampling Locations

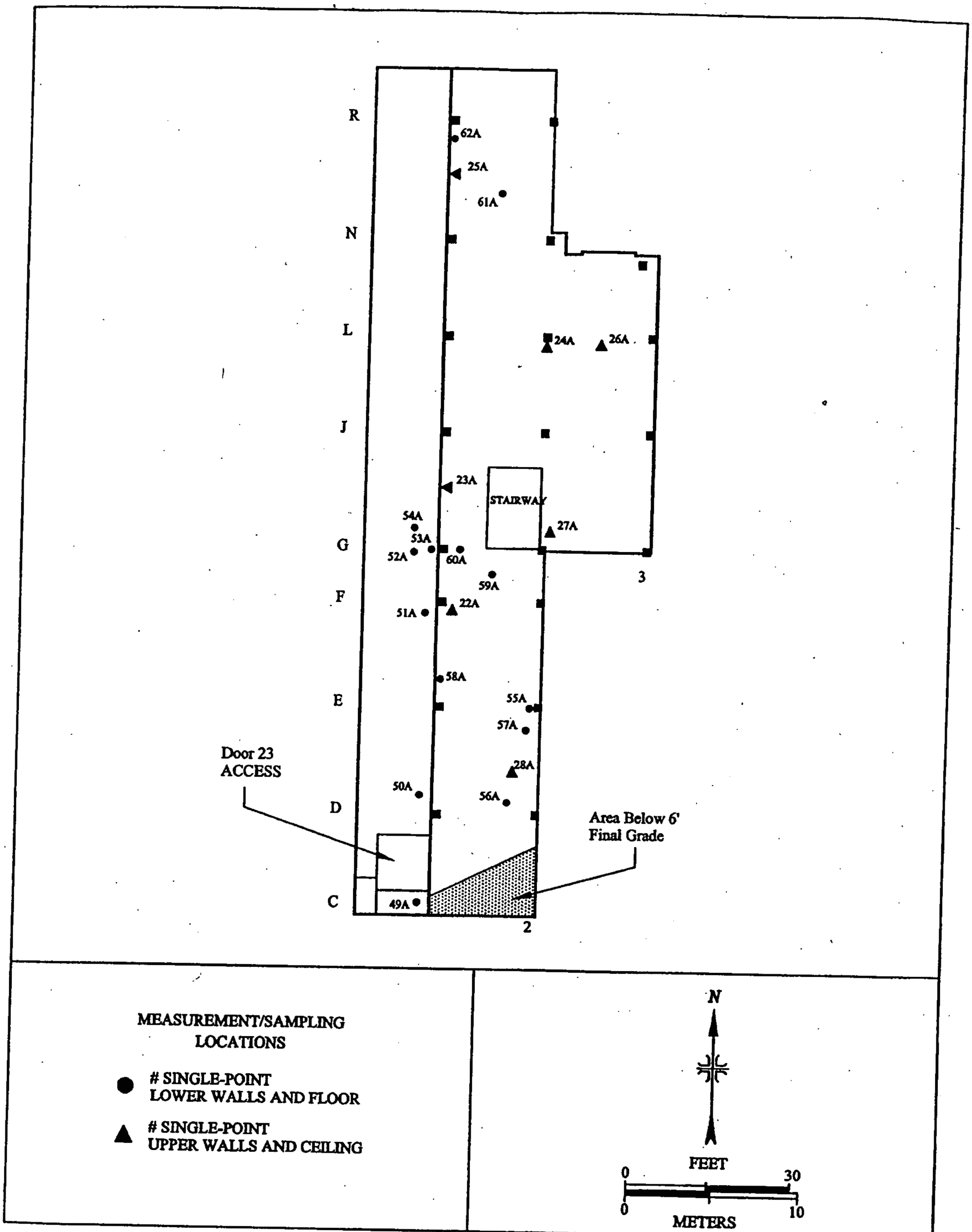


FIGURE 9: Building 771, Second Floor, Survey Unit-771039, Area AH - Measurement and Sampling Locations

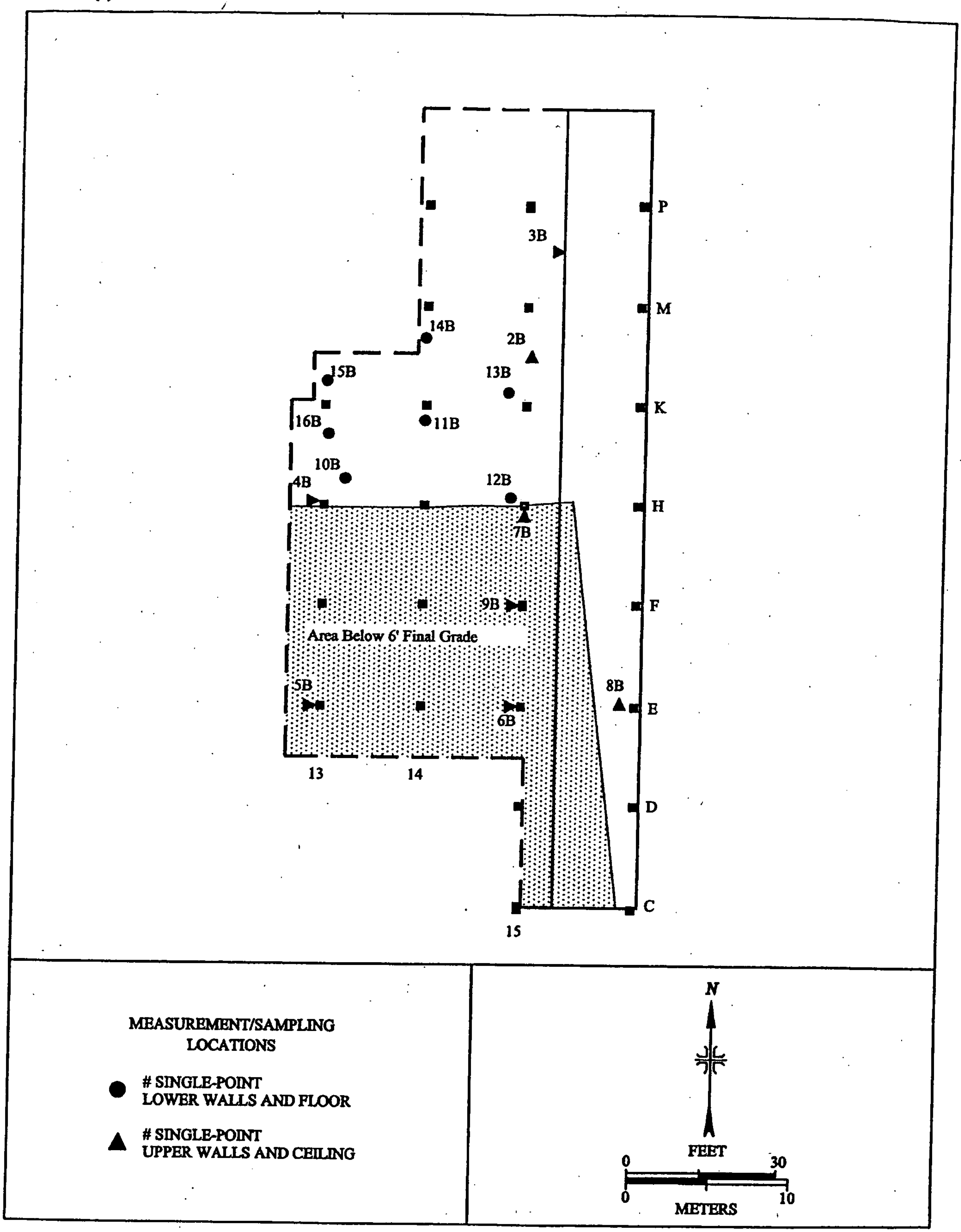
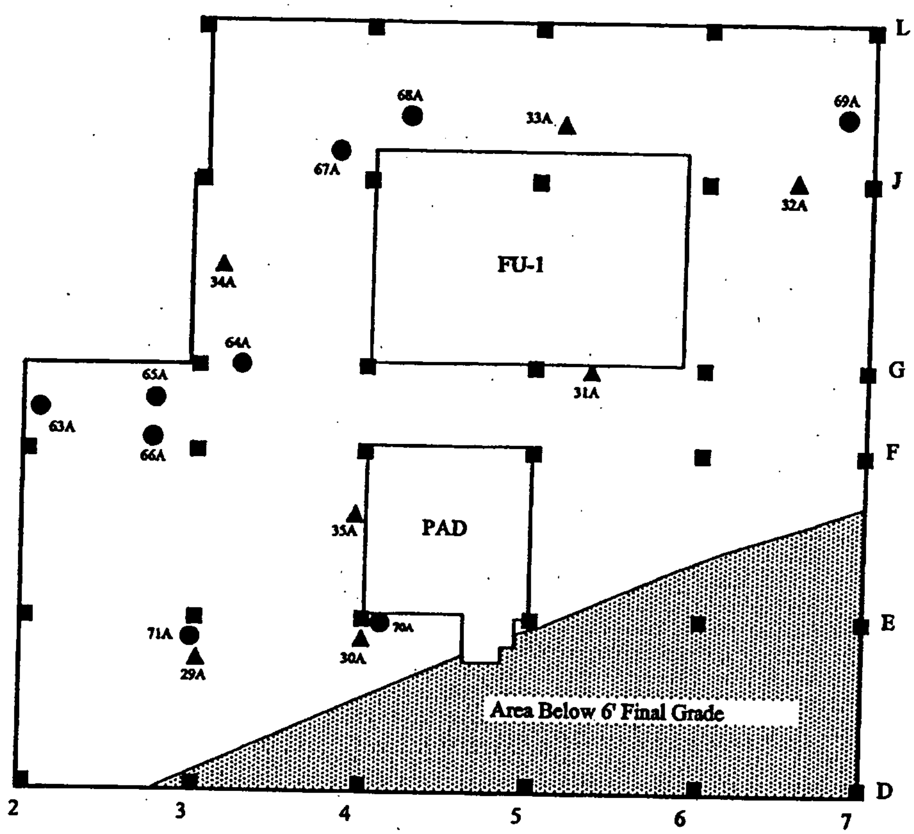


FIGURE 10: Building 771, Second Floor, Survey Unit-771040, Area AH-Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

● # SINGLE-POINT LOWER WALLS AND FLOOR

▲ # SINGLE-POINT UPPER WALLS AND CEILING

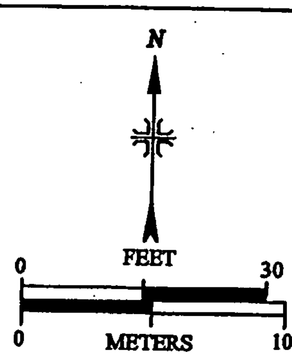
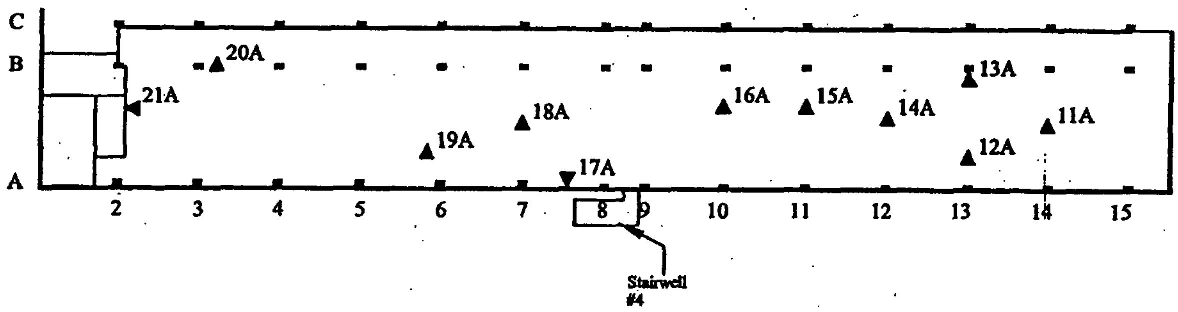


FIGURE 11: Building 771, Second Floor, Survey Unit-771041, Area AH-Measurement and Sampling Locations



771043

MEASUREMENT/SAMPLING LOCATIONS

▲ # SINGLE-POINT
UPPER WALLS AND CEILING

NOT TO SCALE

FIGURE 12: Building 771, Second Floor, Survey Unit-771043, Area AH - Measurement and Sampling Locations

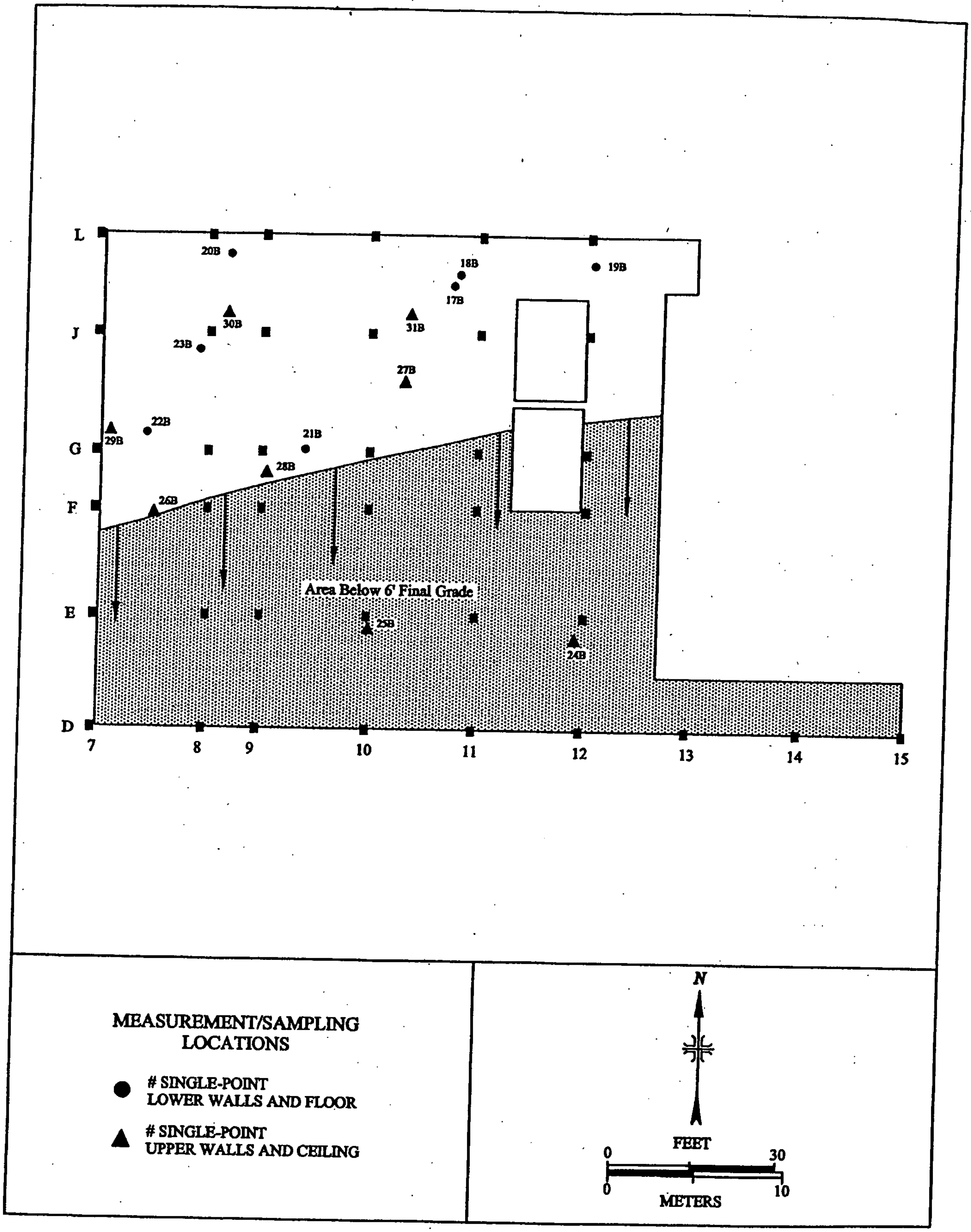
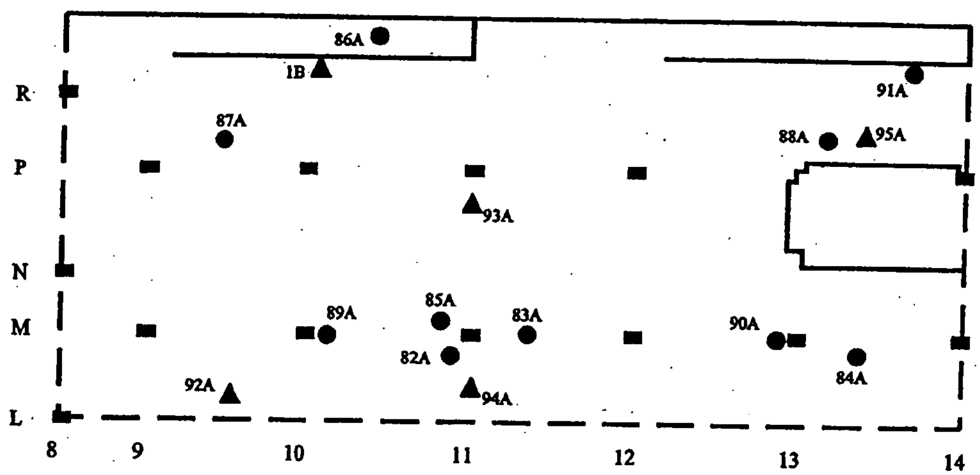


FIGURE 13: Building 771, Second Floor - Survey Unit 771044



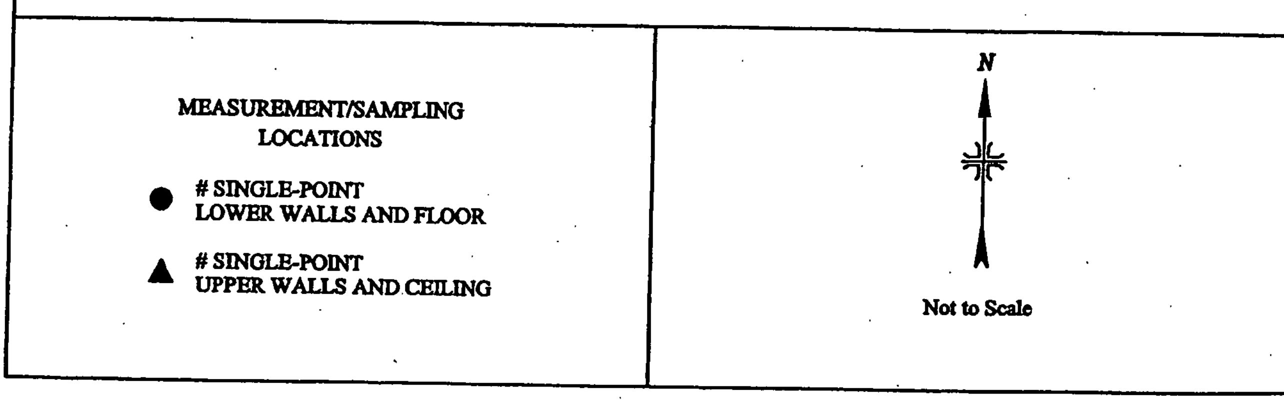


FIGURE 14: Building 771, Second Floor, Survey Unit-771076, Area AH-Measurement and Sampling Locations

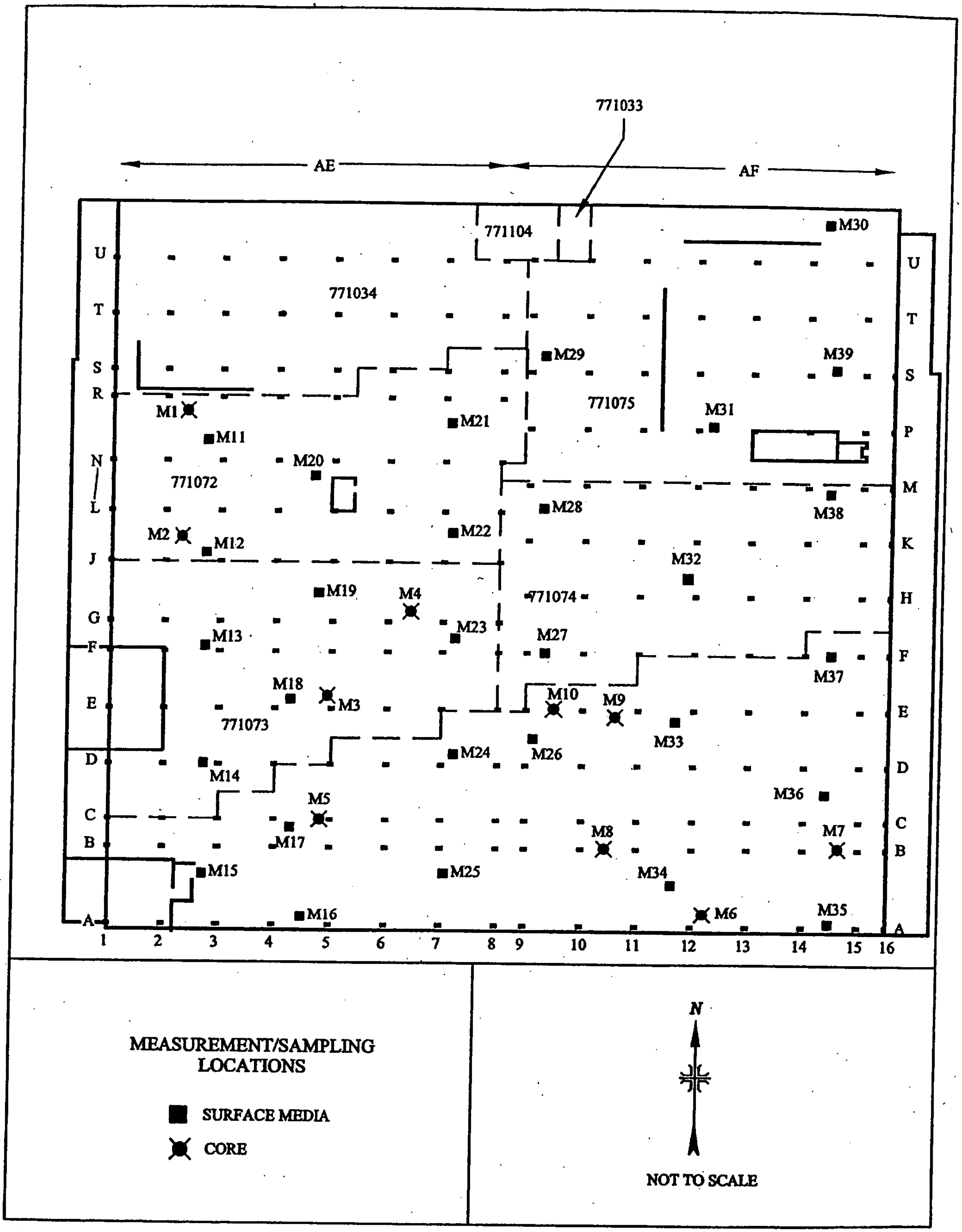


FIGURE 15: Building 771, First Floor (Areas AE and AF) - Core and Surface Media Sample Locations

TABLES

TABLE 1

GAMMA SURFACE ACTIVITY MEASUREMENTS AND VOLUMETRIC CONCENTRATIONS
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	Pu-239 Concentration (nCi/g)[b]
1	260,000	59
2	360,000	80
3	280,000	62
4	320,000	71
5	260,000	57
6	250,000	56
7	260,000	57
8	250,000	56
9	270,000	61
10	600,000	130
11	260,000	59
12	440,000	98
13	290,000	65
14	270,000	60
15	520,000	120
16	290,000	65
17	260,000	58
18	290,000	65
19	370,000	83
20	250,000	56
21	270,000	62
22	250,000	56
23	270,000	60
24	330,000	74
25	250,000	56
26	490,000	110

TABLE 1 (Continued)

GAMMA SURFACE ACTIVITY MEASUREMENTS AND VOLUMETRIC CONCENTRATIONS BUILDING 771 CLOSURE PROJECT ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	Pu-239 Concentration (nCi/g)[b]
27	320,000	71
28	360,000	81
29	320,000	72
30	490,000	110
31	520,000	120
32	390,000	86
33	540,000	120
34	480,000	110
35	340,000	76
36	290,000	64
37	300,000	66
38	400,000	88
39	690,000	150
40	390,000	86
41	640,000	140
42	330,000	73
43	310,000	69
44	280,000	63
45	410,000	91
46	300,000	68
47	330,000	73
48	330,000	73
49	270,000	60
50	260,000	58

[a]Refer to Figure 5.
[b]Calculated based on assumptions in Rocky Flats Calculation Number 05-RS-000.

TABLE 2

TOTAL AND REMOVABLE ALPHA ACTIVITY MEASUREMENT RANGES
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Survey Unit[a]	Survey Area	Survey Unit Classification	Number of Judgmental Measurements	Number of Floor Measurements > 300 dpm/100 cm^2	Number of Wall/Ceiling Measurements > 300 dpm/100 cm^2	Alpha Activity Range (dpm/100 cm^2)	Removable Activity Range (dpm/100 cm^2)
Ceiling	AE	1	16	N/A	0	9 to 230	0 to 7
Ceiling	AF	1	15	N/A	1 (0)[b]	0 to 410	0 to 5
771038	AH	1	23	7 (6)[b]	2 (1)[b]	62 to 5,000	0 to 5
771039	AH	1	21	7	7 (4)[b]	58 to 9,600	0 to 31
771040	AH	1	15	0	0	43 to 270	0 to 11
771041	AH	1	16	7	2 (1)[b]	43 to 13,000	0 to 35
771043	AH	2	11	N/A	0	-14 to 200	0 to 3
771044	AH	1	15	2	1 (0)[b]	65 to 1,700	0 to 16
771076	AH	1	15	6	1 (0)[b]	43 to 5,500	0 to 3

[a]Refer to Figures 6-14.
[b]Value in parenthesis accounts for the differences in calibration methods between ESSAP and Kaiser-Hill

TABLE 3

SURFACE ACTIVITY LEVELS
SURVEY AREA AE, CEILING
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
32B	18	3
33B	120	0
34B	44	0
35B	97	3
36B	62	0
37B	44	0
38B	71	1
39B	110	0
40B	9	0
41B	71	0
42B	62	0
43B	160	0
44B	230	7
45B	62	0
46B	110	1
47B	110	0

[a]See Figure 6.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 4

SURFACE ACTIVITY LEVELS
SURVEY AREA AF, CEILING
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
48B	160	0
49B	9	0
50B	53	1
51B	180	1
52B	9	0
53B	300	0
54B	44	1
55B	35	1
56B	79	1
57B	62	0
58B	53	0
59B	410	5
60B	44	0
61B	97	0
62B	0	0

[a]See Figure 7.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 5

SURFACE ACTIVITY LEVELS
SURVEY AREA AH, SURVEY UNIT 771038
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
36A	71	1
37A	120	3
38A	780	0
39A	190	3
40A	71	1
41A	200	1
42A	160	5
43A	71	1
44A	71	1
45A	97	3
46A	62	0
47A	190	0
48A	220	0
72A	1,900	3
73A	1,500	1
74A	580	0
75A	4,100	1
76A	5,000	0
77A	1,000	1
78A	1,500	0
79A	250	5
80A	340	1
81A	72	1

[a]See Figure 8.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 6

SURFACE ACTIVITY LEVELS
SURVEY AREA AH, SURVEY UNIT 771039
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
22A	79	3
23A	58	0
24A	120	0
25A	200	0
26A	79	3
27A	72	0
28A	94	0
49A	650	1
50A	370	0
51A	580	1
52A	660	0
53A	840	18
54A	1,500	0
55A	510	0
56A	1,300	0
57A	840	1
58A	2,800	0
59A	1,700	1
60A	9,600	0
61A	1,800	7
62A	920	31

[a]See Figure 9.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 7

SURFACE ACTIVITY LEVELS
SURVEY AREA AH, SURVEY UNIT 771040
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
2B	120	0
3B	220	1
4B	200	0
5B	110	0
6B	72	0
7B	43	0
8B	94	0
9B	120	0
10B	160	11
11B	100	0
12B	200	1
13B	270	0
14B	180	0
15B	140	0
16B	220	0

[a]See Figure 10.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 8

SURFACE ACTIVITY LEVELS
SURVEY AREA AH, SURVEY UNIT 771041
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
29A	100	1
30A	43	1
31A	130	0
32A	87	0
33A	79	0
34A	72	0
35A	120	0
63A	3,100	1
64A	1,200	0
65A	1,700	1
66A	3,100	1
67A	2,900	1
68A	1,600	0
69A	710	0
70A	13,000	35
71A	410	0

[a]See Figure 11.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 9

SURFACE ACTIVITY LEVELS
SURVEY AREA AH, SURVEY UNIT 771043
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
11A	180	0
12A	22	0
13A	94	0
14A	29	0
15A	120	0
16A	200	0
17A	65	0
18A	-7	3
19A	-14	0
20A	-14	0
21A	43	1

[a]See Figure 12.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 10

SURFACE ACTIVITY LEVELS
SURVEY AREA AH, SURVEY UNIT 771044
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
17B	1,000	0
18B	1,700	0
19B	220	3
20B	65	0
21B	250	0
22B	120	0
23B	170	0
24B	100	0
25B	300	16
26B	350	3
27B	190	3
28B	210	3
29B	190	1
30B	170	1
31B	270	0

[a]See Figure 13.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 11

SURFACE ACTIVITY LEVELS
SURVEY AREA AH, SURVEY UNIT 771076
BUILDING 771 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity (dpm/100 cm^2)[b]	Total Alpha Removable Activity (dpm/100 cm^2)
82A	4,300	0
83A	4,400	1
84A	2,200	0
85A	680	0
86A	1,200	1
87A	5,500	0
88A	170	1
89A	320	1
90A	200	1
91A	220	3
92A	43	1
93A	220	1
94A	250	3
95A	43	1
1B	240	0

[a]See Figure 14.
[b]ESSAP alpha activity obtained using a 126 cm^2 gas proportional detector. The alpha efficiency is determined in accordance with the ESSAP procedure based on ISO-7503.

TABLE 12

CORE AND RADIONUCLIDE CONCENTRATIONS IN
AREA AE MEDIA SAMPLES
BUILDING 771
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Sample[a] Location	FIDLER Result (cpm)	Measured Am-241 Concentration (pCi/g)	Calculated Pu-239 Concentration (pCi/g)[b]	Total Estimated Am-241 + Pu-239 Concentration (nCi/g)[c]
0967M0001	---[d]	1,880 ± 120	11,000	13
0967M0002	---	303 ± 20	1,700	2.0
0967M0003	---	172,000 ± 10,000	980,000	1,200
0967M0004	---	46.0 ± 4.0	260	0.31
0967M0005	---	922 ± 57	5,300	6.2
0967M0011	3,500	4.45 ± 0.28	25	0.03
0967M0012	23,000	341 ± 19	1,900	2.3
0967M0013	220,000	3,780 ± 320	22,000	25
0967M0014	210,000	6,410 ± 530	37,000	43
0967M0015	3,400	4.47 ± 0.34	25	0.0
0967M0016	29,000	717 ± 41	4,100	4.8
0967M0017	13,000	310 ± 18	1,800	2.1
0967M0018	180,000	4,100 ± 350	23,000	28
0967M0019	3,400	0.52 ± 0.12	3.0	3.5
0967M0020	3,300	0.48 ± 0.09	2.7	3.2
0967M0021	3,200	0.28 ± 0.05	1.6	1.9
0967M0022	3,300	0.30 ± 0.06	1.7	2.0
0967M0023	3,300	0.53 ± 0.07	3.0	3.6
0967M0024	3,400	1.62 ± 0.13	9.2	11
0967M0025	3,100	0.69 ± 0.06	3.9	4.6

[a]Refer to figure 15.
[b]Calculated using 5.7 multiplier for assumed Am-241/Pu-239 ratio as determined from ORISE analysis.
[c]Presented in nanocuries per gram for direct comparison to 100 nCi/g limit (surface samples).
[d]---Core sample locations, surface gamma measurements not collected

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APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or employer.

INSTRUMENT/DETECTOR COMBINATIONS

Gamma

Ludlum Ratemeter Scaler
Model 2221
(Ludlum Measurements, Inc.,
Sweetwater, TX)
coupled to
BICRON NaI Scintillation Detector
Model G5 FIDLER
(Bicron Corporation, Newburg, OH)

Alpha

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-68, Physical Area: 126 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Floor Monitor Model 239-1
combined with
Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Gas Proportional Detector Model 43-37, Physical Area: 550 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

Ludlum Ratemeter-Scaler Model 2221
coupled to
Ludlum Alpha Scintillation Detector Model 43-89 or 43-90, Physical Area: 100 cm^2
(Ludlum Measurements, Inc., Sweetwater, TX)

LABORATORY ANALYTICAL INSTRUMENTATION

Low Background Gas Proportional Counter
Model LB-5100-W
(Canberra/Tennelec, Oak Ridge, TN)

LABORATORY ANALYTICAL INSTRUMENTATION (CONTINUED)

Alpha Spectrometry System
Tennelec Model 256
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors

(Canberra, Meriden, CT) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden,CT)

Alpha Spectrometry System
Canberra Model 7401VR
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(EG&G ORTEC, OAK RIDGE, TN)
used in conjuction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

A walkdown of the project area was performed to evaluate the survey areas for potential health and safety issues that may not have been identified by the site. Additionally, the proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in applicable job hazard analyses (JHAs). The procedures entailed minimal potential hazards that were currently addressed in ESSAP JHAs.

Personnel adhered to the site health and safety requirements. Project training requirements were met prior to entry into the survey areas. General employee radiological training for site access was completed and the IV team completed beryllium worker qualification, including on-site physical, chest x-ray, and classroom lecture. In addition, the IV team received building specific entry and safety requirements. Confirmatory survey activities were conducted in areas that were not downposted for radiation or beryllium contamination and site dosimetric considerations were applicable.

QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual (September 2004)
- Laboratory Procedures Manual (August 2004)
- Quality Assurance Manual (August 2004)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1C and the U.S. Nuclear Regulatory Commission

Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Calibration

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Instrumentation had to be re-calibrated once at the site because of the effect of altitude on detection capability. Detectors used for assessing surface activity were calibrated in accordance with ISO-7503[1] recommendations. The total efficiency (ϵ_{total}) was determined for each instrument/detector combination and consisted of the product of the 2π instrument efficiency (ϵ_i) and surface efficiency (ϵ_s): $\epsilon_{total} = \epsilon_i \times \epsilon_s$

The alpha calibration efficiency for detectors used for the project, calibrated to Am-241 was typically between 0.10 and 0.11. The alpha calibration source was selected based on the alpha energy distribution of the radionuclide of concern. ISO-7503 recommends an ϵ_s of 0.25 when measuring alpha emitters and beta emitters with a maximum energy of less than 0.4 MeV and a ϵ_s of 0.5 for maximum beta energies greater than 0.4 MeV. Calibration source emission rates were corrected for geometry when the sources used were smaller than the detector window area.

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[1]International Standard. ISO 7503-1, Evaluation of Surface Contamination - Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters. August 1, 1988.

The gamma calibration efficiency for the FIDLER detector was determined to ISO-7503 recommendations. A NIST traceable Am-241 calibration source (maximum gamma energy of 59.5 KeV) was used to develop the optimal instrument efficiency using a 4 π source activity. The calculated ϵ_{total} ranged between 0.08 to 0.11, depending on the detector. The calibration source emission rates were corrected for geometry when a source larger than the detector was used.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detector slowly over the surface; the distance between the detectors and surface was maintained at a minimum, nominally about 1 cm. A large surface area (600 cm^2) gas proportional floor monitor was used to scan the floors in the low-bay area. Other surfaces were scanned using a small area 126 cm^2 hand-held proportional detector or a 100 cm^2 dual phosphor detector. Areas greater than six feet below final grade were scanned using a low energy photon FIDLER detector with a detector area of 127 cm^2. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Finally, the use of a 100 cm^2 hot spot size allows the calculation of alpha scan MDC in units of dpm/100 cm^2.

In considering an evaluation of the scan MDC for Pu-239 on a concrete slab, a scan speed of 3 cm/s is assumed such that a residence time of 3.33 seconds is maintained over the contamination. Typically, an instrument efficiency is assumed to be 0.44 and the surface efficiency is 0.25 according to ISO-7503. The scan MDC is based on a 90% probability of detecting one count: Using these parameters this equation yields a scan MDC of 380 dpm/area depicted as follows:

$$\alpha \text{ scan MDC} = \frac{[-\ln(1-0.9)]60}{(0.44)(0.25)(3.33)} = 380\ dpm/100\ cm^2$$

For backgrounds greater than zero, e.g., 1 to 3 cpm, the calculational approach and scan MDC result are still valid, however, it is at the expense of an increased false positive rate. That is, the surveyor will be more likely to mistake background as contamination. For background count rates on the order of 5 to 10 cpm, a single count should not cause a surveyor to investigate further, primarily because there would be an inordinate amount of false positives.

Specific scan MDCs for the NaI scintillation detector for the radionuclide mixture in concrete were not determined as the instrument was used solely as a qualitative means to identify elevated gamma activity however, MDCs for radionuclides in the concrete would approximate those contained in NUREG-1507.

Surface Activity Measurements

Measurements of total surface activity levels were primarily performed using gas proportional detectors with portable ratemeter-scalers. Surface activity measurements were performed on upper room surfaces, some equipment, and at locations of elevated direct radiation, using gas proportional detectors with ratemeter-scalers.

Gamma surface activity measurements were performed using the FIDLER detector. A Microshield™ program calculation was performed based upon calibration variables and detector attributes to determine a field action level. The result calculated a field action level of 250,000 cpm that was used to conduct additional investigation.

Count rates (cpm), which were integrated over one minute with the detector held in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the total efficiency ($\epsilon_i \times \epsilon_s$) and correcting for the active area of the detector.

Because different building materials (poured concrete, brick, wood, steel, etc.) may have different background levels, average background count rates were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history.

Gamma count rates were integrated over one minute using the FIDLER. Count rates (cpm) were converted to nanocuries per gram (nCi/g) using the following equation:

$$\left(\frac{cpm}{\varepsilon_T * \varepsilon_p * 127cm^2}\right) * \left(\frac{127\ cm^2}{W}\right) * \left(\frac{nCi}{2220dpm}\right) * 8\frac{Pu}{Am}$$

where:

ε_T = Total Efficiency = 0.08
ε_p = Attenuation Correction Factor for Painted Surfaces = 0.679

W = Volume * Density of Concrete = 127cm^2 * 1 cm * 2.35 g/cm^3 = 298.45 g

Note: Volume is calculated as physical detector area x DCGL depth

8 = ratio of Pu-239 to Am-241 for 35-year old WGP

Removable Activity Measurements

Removable gross alpha and gross beta activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

Miscellaneous Sampling

Concrete cores were taken using a mechanical hole saw to a minimum depth of six inches. Concrete samples were taken by chipping material from approximately 100 cm^2 of surface. The samples were then placed in a plastic bag or other appropriate container, sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Gross Alpha

Smears were counted on a low-background gas proportional system for gross alpha activity. Typical MDCs of the procedure were 9 dpm/100 cm^2 for gross alpha and 15 dpm/100 cm^2 for gross beta.

Alpha Spectroscopy

Samples were crushed and homogenized and dissolved by potassium fluoride and pyrosulfate fusion and the elements of interest were precipitated with barium sulfate. Barium sulfate precipitate was re-dissolved and the specific element of interest—isotopic plutonium—was individually separated by extraction chromotography and re-precipitated with a cerium fluoride carrier. The precipitate was then analyzed using ion implanted detectors (Canberra), alpha spectrometers (Tennelec and Canberra), and a multichannnel analyzer (Canberra). The typical MDC of the procedure for a 1000 minute count time is 0.02 pCi/g (solids).

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 3 plus 4.65 times the standard deviation of the background count [$3 + (4.65 \sqrt{BKG})$]. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5 (DOE 1990)

BASIC DOSE LIMITS

The basic dose limit for the annual radiation (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

SURFACE CONTAMINATION GUIDELINES

Allowable Total Residual Surface Contamination

Radionuclides[b]	(dpm/100 cm^2)[a] Average[c,d]	Maximum[d,e]	Removable[d,f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th_Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U_Natural, U-235, U-238, and associated decay products	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000	15,000	1,000

[a]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[b]Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[c]Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d]The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

[e]The maximum contamination level applies to an area of not more than 100 cm^2.

[f]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

APPENDIX D

SELECTED SECTIONS OF BUILDING 771/774 CLOSURE PROJECT CHARACTERIZATION PLAN FOR AREAS GREATER THAN SIX FEET BELOW FINAL GRADE

FINAL

11/14/03

INTRODUCTION

This Characterization Plan identifies the characterization and verification approach for portions of Building 771/774 that contain fixed areas of contamination. As stated in the 771 Closure Project Decommissioning Operations Plan Modification 5 (DOP), the objective of this characterization plan is to ensure that the nature and extent of contamination is adequately defined and that the material that will be left in place is consistent with the framework for contaminated soil. The areas that have not been decontaminated to the unrestricted release criteria and will remain in place after backfilling will be characterized in accordance with this project-specific characterization package prepared in accordance with the Decontamination and Decommissioning Characterization Protocol and the Industrial Area Sampling and Analysis Plan. The slab and structure within 0 to 6 feet of the final proposed grade will be decontaminated to the unrestricted release criteria and 0 to 3.5 feet will be removed during demolition. The Building 771/774 slab and structure below 6 feet of the final proposed grade will be decontaminated to ensure that it will not exceed 7 nCi/g (over depth of volume) and/or 100 nCi/g (surface). The described characterization methods are based on the Data Quality Objectives of the Industrial Area Sampling and Analysis Plan (IASAP)(DOE 2001a).

1.0 EXISTING CHARACTERIZATION INFORMATION

The contaminant of concern in Building 771/774 is weapons-grade plutonium, which consists primarily of Pu-239/240 and Am-241 (which is present as a result of ingrowth from the decay of Pu-241). These three isotopes represent over 98% of the total activity per gram of WGP. Other incidental radionuclides were utilized for various processes in Building 771 and 774, including enriched and depleted uranium, and mixed fission products (MFP). However, a review of the *in-situ* gamma-spectroscopy data did not indicate the presence of the associated radioisotopes on structural surfaces (refer to Attachment A).

The locations of the existing random *in-situ* data were selected per the requirements of RSP-09.09, Radiological Characterization of Low Specific Activity Waste by Field Sampling and Analysis. This procedure describes a method to calculate conservative estimates of material activity concentration based on random sampling and calculation of the upper confidence limit (UCL_{95}) of the mean concentration. The statistical evaluation also assumes a lognormal distribution with the intention of biasing results high to provide a high degree of confidence that no transportation or waste acceptance criteria is exceeded. However, because many areas exceeding the specified limits have been identified through this sampling effort, no statistical evaluations of the existing data set will be performed. However, a statistical evaluation will be performed for verification sample data, as described in Section 5.0.

Each characterization unit represented one room or area with similar process histories and contamination potential. Building 771 was divided into seven areas and fifteen random measurements were collected in each unit (with the exception of the Room 182, from which five samples were collected due to previously-existing work interferences). Additional biased *in-situ* measurements were collected in Room 148 and in Building 774. Ninety (90) paint samples were collected on the second floor of Building 771 as part of the Reconnaissance Level Characterization (RLC) effort. Fifteen (15) paint samples were collected in Room 241 of Building 774 were also collected during RLC. Additional biased ZnS measurements were collected in non-process areas of Building 771 as part of Phase 2 of the UBC characterization effort. Additional paint and *in-situ* measurements were collected in the Building 771/776 tunnel as part of the hydrolazing waste characterization effort. A summary of the type of data collected is presented in Table 1.

A total of 297 biased and random data points have been collected. Thirty-three (33) of the *in-situ* data points, were collected on structural walls and ceilings. None of these structural wall/ceiling data points exceeded 100 nCi/g at the surface and/or 7 nCi/g averaged over the wall/ceiling depth. Based on the *in-situ* gamma spectroscopy data, the average volumetric activity is approximately 9 nCi/g for the slab and 0.03 nCi/g for the wall/ceiling surfaces, indicating that greater than 99% of the remaining activity exists in the slab.

Floor and wall shots in Old Tank 40 (B774) did indicate contamination in excess of 100 nCi/g at the surface. Therefore, remediation will be required on the walls as well as the slab of Old Tank 40.

A summary map of the results for the first floor of Building 771 and Building 774 is presented in Figure 1. No summary map is presented for the second floor of Building 771, given that all surface paint sample results were less than 1 nCi/g.

2.0 POST-REMEDIATION SCANNING (> 6' BELOW FINAL GRADE)

Following the decontamination of the slab, a 100% scan of the slab surfaces will be performed with a qualitative field instrument to verify that all areas in excess of 100 nCi/g have been remediated. Any area flagged as potentially greater than 100 nCi/g will either be remediated or verified to be less than 100 nCi/g with a quantitative instrument (i.e., in-situ gamma-spectroscopy or laboratory sample analysis method).

3.0 VERIFICATION SAMPLING (> 6' BELOW FINAL GRADE)

Following completion of remediation activities and the collection of biased post-remediation data, an additional verification sampling effort will be performed on slab surfaces that will remain *in-situ* 6' below final grade. The objective is to verify with 95% confidence that the average slab activity is less than 100 nCi/g (surficial) and 7 nCi/g (volumetric) Pu-239 and Am-241, and to provide an estimate of the average remaining slab activity. In addition, the data will be evaluated for the presence of other incidental radioisotopes, including Radium-226 and Uranium-235, although existing data does not indicate the presence of these isotopes in 771 (refer to Attachment A). The locations of the random sample locations will be selected per a simple non-parametric statistical method (Sign Test) described in Section 8.3 of the MARSSIM manual (refer to Attachment B). Building 771 will be divided into three units, and 774 into one unit (refer to Table 3). The number of samples required will be based on standard deviation estimates derived from existing data, and verified to be adequate based on actual standard deviations.

4.0 NON-RADIOLOGICAL CONTAMINANTS

The non-radiological contaminants of concern, including beryllium (Be), asbestos (ACM), poly-chlorinated bi-phenyls (PCBs), RCRA contaminants, including lead (Pb), will be evaluated per existing site requirements for demolition. A discussion of each contaminant and path forward is provided below.

Beryllium will be evaluated per the requirements of the PDSP. Asbestos shall be removed and controlled per the requirements of Colorado Department of Public Health and Environment Regulation No. 8, Part B, and OSHA 29 CFR 1926.1101. PCB-based paints shall remain in place and the control measures outlined in the Risk-Based Approach memorandum (8EPR-F) shall be implemented during demolition. RCRA contaminants, including any RCRA closures, shall be evaluated per the requirements of the B771 DOP. Lead analysis of paint from the process areas of the 771/774 complex has revealed lead levels above regulatory limits in only one out of 61 samples taken, and the elevated level was only found in the stack exhaust tunnel (on an orange-colored sealant). Additional sampling will be performed in the exhaust tunnel in order to determine the path forward.

5.0 REPORTS

Upon completion of verification sampling, a final report shall be generated that includes the information described below.

- An overview map delineating decontaminated areas and post-remediation sample results
- The individual verification sample results and statistical evaluation (by survey unit)
- The average remaining activity (by survey unit)
- The conclusion for each survey unit

6.0 MAPS

The final grade maps are presented in Figure 2.

7.0 REFERENCES

DOE, 2001, Industrial Area Sampling and Analysis Plan, Rocky Flats Environmental Technology Site, Golden, Colorado, June.

MAN-127-PDSP, Pre-Demolition Survey Plan for D&D Facilities, Revision 0, Golden, Colorado, April 23, 2001.

PRO-1564-RSP-09.09, Radiological Characterization of Low Specific Activity Waste by Field Sampling and Analysis, Revision 0, Golden, Colorado, 9/26/02.

Appendix E

Analytical Results and Case Narrative for the Investigation of Americium-241 Concentrations in Building 771 Concrete Core Samples, Rocky Flats Environmental Technology Site Closure Project, Golden, Colorado.

October 13, 2004

Mr. Warren Seyfert
U.S. Department of Energy
Rocky Flats Project Office
10808 Hwy 93, Unit A
Golden, CO 80403

SUBJECT: DOE CONTRACT NO. DE-AC05-00OR22750 ANALYTICAL RESULTS AND CASE NARRATIVE FOR THE INVESTIGATION OF AMERICIUM-241 CONCENTRATIONS IN BUILDING 771 CONCRETE CORE SAMPLES, ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE CLOSURE PROJECT, GOLDEN, COLORADO

Dear Mr. Seyfert:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education performed analysis of concrete core samples collected from Building 771. The core sample collection and analysis was a part of the independent verification activities performed to validate the Kaiser-Hill (K-H) pre-demolition survey results.

ESSAP selected five floor locations where elevated direct gamma radiation in excess of 100,000 counts per minute had been identified during the verification survey of Area AE located on the Building 771 first floor. K-H provided the necessary equipment and personnel to obtain the concrete core samples from the floor slab. Samples were collected on July 29, 2004 and transferred under chain-of-custody to the site's laboratory for analysis. The site laboratory conducted the analyses to determine if the Building 771 subgrade combined americium-241 and plutonium volumetric contamination criteria had been met and to prepare the samples for shipment to the ESSAP laboratory for verification analysis.

The samples were shipped to ESSAP and results of the site's analysis provided for data comparison. Normally, concrete core samples received in the laboratory are crushed and homogenized and the sample placed into a standard geometry and counted by gamma spectroscopy. However, the anticipated high activity levels of the cores prevented the laboratory from following this standard protocol. The ESSAP laboratory elected to count each core sample as is. The unique geometry of the core and the inhomogenous nature of the contamination required the development of a specialized, reproducible counting geometry and efficiency determination. Enclosed is the case narrative describing the methodologies and analytical results for the analysis of the five core samples. The appendices referenced in the narrative have not been included but are available upon request.

The results of the study indicate that the K-H laboratory's reported Am-241 concentrations were an average of 10 times less when compared to ESSAP's analytical results. A summary of the results is provided in the table below:

Am-241 Concentration (pCi/g)		
Sample ID Number	**ESSAP Results**	**K-H Results**
M001	1,204 to 2,796	198
M002	70.3 to 500	26.9
M003	49,910 to 194,500	9,710
M004	46.0 to 109.6	11.9
M005	288 to 1,048	125

It is ESSAP's opinion that the apparent underestimation of volumetric concentrations would result in K-H incorrectly concluding that radionuclide concentrations in isolated areas of the subgrade floor slab of Building 771 are less than the decontamination criteria of 7 nCi/g average activity over the depth of the slab.

Please contact either Phyllis Weaver at (865) 576-5321 or Dale Condra at (865) 241-3242 should you have any questions or require additional information.

Sincerely,

Timothy J. Vitkus
Survey Projects Manager
Environmental Survey and
Site Assessment Program

TJV:ar

Enclosure

cc: E. Abelquist, ORISE/ESSAP
D. Condra, ORISE/ESSAP
P. Weaver, ORISE/ESSAP
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File/0967

Distribution approval and concurrence:	**Initials**	**Date**
Technical Management Team Member		
Laboratory Manager		
Quality Manager		

CASE NARRATIVE

Gamma Spectroscopy of Rocky Flats Building 771 Concrete Core Samples Using a Uniform Contamination Distribution Geometry

October 13, 2004

INTRODUCTION

ESSAP collected 3.5 centimeter (cm) diameter concrete core samples from Rocky Flats Building 771 to a depth of approximately 16.5 cm, or 6.5 inches. An investigation of the contamination distribution of the various samples found that the activity is not uniform throughout the sample. Contamination varies significantly through the length of the samples (vertically) and to a lesser extent radially (horizontally). To assess the radionuclide concentration of americium-241 (Am-241) present in each of the samples, ESSAP performed concurrent, independent gamma spectroscopy measurements using two methodologies.

The first methodology was performed by the ESSAP Laboratory staff. ESSAP calibrated the laboratory gamma detectors using a quantity of material taken from the 2003 full Marinelli[5] geometry multi-gamma standard QCY48. A multi-gamma standard was prepared to approximate the dimensions and density of the samples and was blended uniformly throughout the geometry. The developed efficiency was then used to quantify Am-241 concentrations within five core samples (0967M001, 0967M002, 0967M003, 0967M004, and 0967M005). Lastly, two samples with the lowest measured activities (0967M002 and 0967M004) were selected to be blended for measurement in a standard geometry for which the ESSAP Laboratory has performance evaluation (PE) results.

The second methodology was performed by the ESSAP Survey staff. ESSAP set up the *in situ* gamma spectroscopy (ISGS) system using ISOCS version 3 and PROcount 2000 version 1.1 software packages to perform measurements of the QCY48 fabricated standard discussed above and three of the core samples (0967M001, 0967M002, and 0967M005). The results were compared to ESSAP Laboratory results determined by calibrating to the uniform standard. The ISGS results were considered qualitative because a rigorous quality control (QC) data set was not maintained for the ISGS system. Finally, an investigation as to the effect of employing non-uniform ISOCS efficiency models was completed.

FABRICATED STANDARD

The ESSAP Laboratory prepared a simulated concrete core using multi-gamma standard QCY48 uniformly distributed in a sand matrix and sealed in a plastic pipe with an inside diameter of 3.8 cm and a length of 16.5 cm. A modified 1-liter (L) Marinelli was created to hold the sample and the standard was counted in the horizontal position. After the standard was counted, the efficiency for this geometry was generated and approved.

[5]Full Marinelli is ESSAP's terminology for samples in 0.5L Marinelli with a density of approximately two grams per cubic centimeter (g/cm^3).

To verify the calibration efficiency, a separate sample was prepared in the same configuration using multi-gamma standard QCY48, from the year 2000, uniformly distributed in a sand matrix and counted. Since Am-241 was the primary radionuclide of concern, the Am-241 concentration was the only radionuclide that was evaluated. The ESSAP Laboratory uses the ratio of the measured value to known value to verify if the efficiency calibration is correct. The ratio of these values should be statistically equal to one. The measured to known value ratio for Am-241 was 1.08 ± 0.09.

The fabricated standard was also measured using the ISGS system. The ISGS result for Am-241 was compared to the known standard radionuclide concentration. The measured to known value ratio was 0.98 ± 0.14. Appendix A provides the ISGS measurement results as well as documentation of the ISOCS efficiency model.

ROCKY FLATS SAMPLES

The core samples were counted in the calibrated geometry using the ESSAP Laboratory gamma spectroscopy system. For the initial count, each sample was randomly placed on the modified 1L Marinelli. Each sample was counted long enough to limit the counting statistics error to 1% or less. Once the concentration of Am-241 for each sample was calculated, a comparison of the results to the Rocky Flats contractor was performed. The results generated by ESSAP ranged from factors of 3.9 to 17.7 times higher than the Rocky Flats results. The concentrations and comparisons are presented in Table 1.

After the results were reviewed, the decision was made to crush and blend sample 0967M004, which had the lowest concentration, and count the blended sample in a geometry for which there are PE results. Once the blending was complete, the sample was passed through a 35 mesh sieve and two Hockey Puck Light[6] (HPL) geometry aliquots were prepared. Each side (top and bottom) of each sample aliquot was counted. The results indicate that even after extensive blending there is a possibility for discrete particles to be present in the sample. The data for the sample counts are presented in Table 2.

After further discussions, it was decided that each core sample would be marked length-wise into four sections and each section would have the same count time. Each sample package was marked into four sections. The sections were arbitrarily numbered one through four. The count of each sample started with section one and rotated 90 degrees until all sections had been counted. The results of the four counts were averaged.

Concurrently, ESSAP's ISGS system was used to develop ISOCS efficiencies for the three Rocky Flats samples discussed above. Using geometry input values, ISOCS calculates a sample weight. Table 3 presents the ESSAP Laboratory measured weight and ISOCS calculated weight. As can be seen in the table, there is good agreement for all three samples, validating the physical parameters entered for each ISOCS model.

Each sample was then measured on the ISGS system in the same method as the ESSAP Laboratory. The sample was placed in the modified 1L Marinelli so that the side of the sample

[6]Hockey Puck Light is ESSAP's terminology for samples in a 2.3 cm × 7.6 cm plastic container with a density of approximately 1.5 g/cm^3.

faced the detector with a distance of 4.5 cm between the detector and the point on the sample closest to the detector. A spectrum was collected for 600 seconds, then the sample was rotated axially 90-degrees to perform another measurement. Four measurements were performed at four rotation angles that corresponded to the ESSAP Laboratory measurements. For example, for the ISGS system measurement at Rotation #1, the sample was placed such that the writing indicating measurement "1" was facing upward, or on the opposite side of the detector.

Table 4 provides the ESSAP Laboratory and ISGS rotational measurement results for all four samples and each rotation. Note that the uncertainty in the ISGS measurements is a function of the user-input errors associated with the ISOCS calculation. Software recommended values were used as inputs. The percent difference between the ESSAP Laboratory results and ISGS results ranged from -46.4% to 18.9%. Results were statistical for 9 of 12 measurements. Of the 12 measurements, 7 of the ISGS results were greater than and 5 were less than the ESSAP Laboratory results. Due to the high activity present in the sample, ISGS measurements were not performed for sample 0967M003.

Table 5 provides calculation results for average and standard deviation (of the average) for the four rotations for each sample. The percent difference results showed good agreement with a range from -6.7% to -0.7%—the ISGS system average values were greater than the ESSAP Laboratory measurements.

After the results from the rotational counts were reviewed, the decision was made to crush and blend sample 0967M002, again because it had the next lowest concentration, and count the blended sample in a geometry for which there are PE results. Once the blending was complete, the sample was passed through a 35 mesh sieve and two HPL aliquots were prepared. Each side (top and bottom) of each sample aliquot was counted. The results, when compared to the data generated from counting the solid core, indicate the possibility that the contamination was predominantly in the interior of the core sample. If the contamination were inside the core, the photon from Am-241 would be attenuated producing analytical results that would be underestimated by these methodologies. The data for the sample counts are presented in Table 2.

Appendices B, C, and D provide the ISGS measurement results as well as documentation of the ISOCS efficiency models developed for samples 0967M001, 0967M002, and 0967M005. Appendix E provides the ESSAP Laboratory results for samples 0967M001, 0967M002, 0967M003, 0967M004, and 0967M005.

NON-UNIFORM ISGS MODELING

Because the two methodologies presented above utilized uniform contamination distributions for efficiency determination, the effects of using a non-uniform ISOCS ISGS system model were investigated. Using the ISOCS simple cylinder model, the 60 keV energy efficiency for Am-241 was determined for varying length (depth) of the contaminated layer. In other words, the contamination was modeled as nearly surface contamination on one end of the sample to fully uniform contamination through the length of the sample. Twenty efficiency calculations were performed and are presented in Table 6. The data from Table 6 are plotted in Figure 1 as the efficiency versus length of contamination. The resultant relationship is such that there are two inflection points. As can be seen from Figure 1, the minimum efficiency occurs when the contamination layer is approximately 2.5 cm and the maximum efficiency at approximately 11.4 cm.

To independently validate the ISOCS results, MicroShield version 5.05 was used to replicate the concrete core model used as input for the ISOCS model. With the MicroShield model, the dose point was set at the center of the end-cap of the ISGS detector. Several lengths of the contamination layer were modeled and the results were consistent with the ISOCS model. Two inflection points were observed with the same S-shaped response curve demonstrated in Figure 1.

Based on the mathematical results, an approximate bounding on the error of calibrating to a uniform contamination distribution can be estimated. Using the uniform efficiency as the point of reference, the actual results may be underestimated by approximately 10%[7] if the core was uniformly contaminated to a length of 11.4 cm. Conversely, the actual results could be overestimated by 26%[8] if the core was uniformly contaminated to a length of 2.5 cm. The limitation of this modeling technique and error estimation is that it was still assumed that the contamination was uniformly distributed throughout the length of the contaminated layer.

From review of the gamma spectroscopy measurements presented above and scanning of the samples using hand held radiation detection meters, the actual contamination is highly variable both radially and through the length of the sample. The rotational measurements were used to address the radial distribution when using a uniform model. To more accurately determine the average contamination in the sample with respect to the variable contamination distribution through the length of the sample, the ISOCS complex cylinder model could be used, which uses the input of four contamination layers and their relative contamination distribution. With this model, an exponential distribution could be input for calculating the efficiency of the ISGS system. Due to time constraints, this modeling was not employed.

The ISOCS efficiency calculations are provided in Appendix F.

CONCLUSION

ESSAP performed gamma spectroscopy of Rocky Flats concrete cores from Building 771 using two independent assessment methodologies based on calibrating to a uniform contamination distribution. The results indicate that average values reported by Rocky Flats for Am-241 average contamination in the samples are underestimated—in some cases significantly underestimated. After blending selected samples for measurement, using an ESSAP Laboratory standard geometry, the Am-241 concentrations increased from the initial measurements, demonstrating the non-uniform contamination distribution in the samples.

Because of the identified non-uniform nature of the contamination, mathematical modeling of the detector efficiency was performed to determine the impact of assuming a uniform distribution when in fact the samples were not uniformly contaminated. The mathematical results indicated that the uniform efficiency determined by the ESSAP Laboratory and calculated for the ESSAP ISGS system produced representative concentrations. While employing a more

[7]Calculated using ISOCS data from Table 6: (1.63614E-02 – 1.48190E-02) / 1.48190E-02
[8]Calculated using ISOCS data from Table 6: (1.48190E-02 – 1.09608E-02) / 1.48190E-02

complex modeling methodology could result in more accurate calculated efficiencies, it may likely be well within the error associated with measuring a sample that has discrete particles. For example, by blending sample 0967M002, the measured activity of Am-241 increased by 136%. This value was calculated by subtracting the average of the four ESSAP Laboratory rotational measurements from Table 5 (203 pCi/g) from the average of the HPL results from Table 2 (479 pCi/g) then dividing by the rotational results (203 pCi/g). Therefore, the impact of the physical nature of the contamination, e.g. discrete particles, versus the overall contamination distribution through the sample, has a much greater impact on the ability to determine the average Am-241 concentration in a concrete core using available gamma spectroscopy measurement systems.

ORISE TABLE 1

DATA COMPARISON OF CONCRETE CORES
INITIAL SINGLE SAMPLE COUNT MEASUREMENT RESULTS
ROCKY FLATS BUILDING 771

ESSAP Sample ID	ESSAP Laboratory Results (pCi/g)		Rocky Flats Results (pCi/g)		Ratio[b]
	Am-241	TPU[a]	Average Am-241	TPU	
0967M001	1,876	120	198	TPU not reported	9.5
0967M002	303	20	26.9	TPU not reported	11.3
0967M003	172,000	10,000	9,710	TPU not reported	17.7
0967M004	46.0	4.0	11.9	TPU not reported	3.9
0967M005	922	57	125	TPU not reported	7.4

[a]TPU is the total propagated uncertainty of each result at the 95% confidence level.
[b]Ratio is calculated by dividing the ESSAP Laboratory result by the Rocky Flats average result.

ORISE TABLE 2

BLENDED CONCRETE CORE MEASUREMENT RESULTS
ROCKY FLATS BUILDING 771

ESSAP Sample ID[a,b]	ESSAP Laboratory Results	
	Am-241 (pCi/g)	TPU[c] (pCi/g)
0967M002AS1	500	29
0967M002AS2	486	28
0967M002BS1	467	26
0967M002BS2	462	26
0967M004AS1	62.9	3.7
0967M004AS2	67.4	4.0
0967M004BS1	75.2	4.3
0967M004BS2	109.6	6.3

[a]The different sample aliquots are designated by A and B.
[b]S1 designates the top of the samples and S2 designates the bottom of the sample.
[c]TPU is the total propagated uncertainty of each result at the 95% confidence level.

ORISE TABLE 3

WEIGHT COMPARISON OF CONCRETE CORES
ROCKY FLATS BUILDING 771

ESSAP Sample ID	Measured Weight (g)	ISOCS Calculated Weight (g)	Percent Difference[a]
0967M001	420.6	420.24	0.1%
0967M002	365.8	365.17	0.2%
0967M005	379.4	378.78	0.2%

[a]Calculated using the formula: (Measured - Calculated) / Measured

ORISE TABLE 4

MEASUREMENT RESULTS OF CONCRETE CORES
ROCKY FLATS BUILDING 771

ESSAP Sample ID[a]	Rotation[b]	ESSAP Laboratory Results		ESSAP ISGS Results		Percent Difference[e]	Results Statistical?[f]
		Am-241 (pCi/g)	TPU[c] (pCi/g)	Am-241 (pCi/g)	TPU[d] (pCi/g)		
0967M001	1	1,204	72	1,562	214.2	-29.7%	No
	2	1,570	94	1,768	242.4	-12.6%	Yes
	3	2,796	170	2,630	360.2	5.9%	Yes
	4	1,788	107	1,450	199.1	18.9%	No
0967M002	1	372	23	350.7	48.93	5.7%	Yes
	2	145	92	196.7	28.20	-35.7%	Yes
	3	70.3	5	102.9	15.69	-46.4%	No
	4	225	14	216.5	30.96	3.8%	Yes
0967M003	1	49,910	2,946	--[g]	--	--	--
	2	90,020	5,309	--	--	--	--
	3	194,500	11,460	--	--	--	--
	4	74,110	4,371	--	--	--	--
0967M005	1	719	43	833.3	114.7	-15.9%	Yes
	2	1,011	61	1,048	144.0	-3.7%	Yes
	3	551	34	500.0	69.29	9.3%	Yes
	4	288	18	338.9	47.43	-17.7%	Yes

[a]Sample 0967M004 was blended after the initial single measurement, thus rotational measurements were not performed.
[b]Each sample measured four times, rotated axially 90 degrees after each measurement.
[c]TPU is the total propagated uncertainty of each result at the 95% confidence level.
[d]TPU is the total propagated uncertainty of each result at the 95% confidence level (see data package for user input errors associated with ISOCS efficiency calculation).
[e]Calculated (for activity values) using the formula: (Laboratory - ISGS) / Laboratory
[f]Indicates if results overlap, taking into consideration the TPU.
[g]ISGS measurements of sample 0967M003 not performed.

ORISE TABLE 5

DATA COMPARISON OF CONCRETE CORES ROCKY FLATS BUILDING 771 UNIFORM CONTAMINATION DISTRIBUTION

ESSAP Sample ID[a]	Laboratory Results (pCi/g)		ISGS Results (pCi/g)		Percent Difference[b]
	Average Am-241	Standard Deviation	Average Am-241	Standard Deviation	
0967M001	1,840	682	1,853	535	-0.7%
0967M002	203	129	217	102	-6.7%
0967M003	102,135	63,747	--[c]	--	--
0967M005	642	303	680	320	-5.9%

[a]Each sample measured four times, rotated axially 90 degrees after each measurement.
[b]Calculated (for average values) using the formula: (Laboratory - ISGS) / Laboratory
[c]ISGS measurements of sample 0967M0003 not performed.

ORISE TABLE 6

MATHEMATICALLY CALCULATED Am-241 EFFICIENCIES BY VARYING THE LENGTH OF CONTAMINATION OF THE MODELED CONCRETE CORES FROM ROCKY FLATS BUILDING 771

Length of Contamination[a] (cm)	ISOCS Calculated 60 keV Efficiency
0.0254	1.36587E-02
0.127	1.34086E-02
0.254	1.31184E-02
0.381	1.28510E-02
0.508	1.26049E-02
0.635	1.23817E-02
1.27	1.15466E-02
1.905	1.11030E-02
2.54	1.09608E-02
3.81	1.13069E-02
5.08	1.21483E-02
6.35	1.32291E-02
7.62	1.44003E-02
8.89	1.54126E-02
10.16	1.60986E-02
11.43	1.63614E-02
12.7	1.62603E-02
13.97	1.58941E-02
15.24	1.53904E-02
16.51	1.48190E-02

[a]Simple cylinder ISOCS model used with length of top layer entered as presented with bottom layer data not entered.

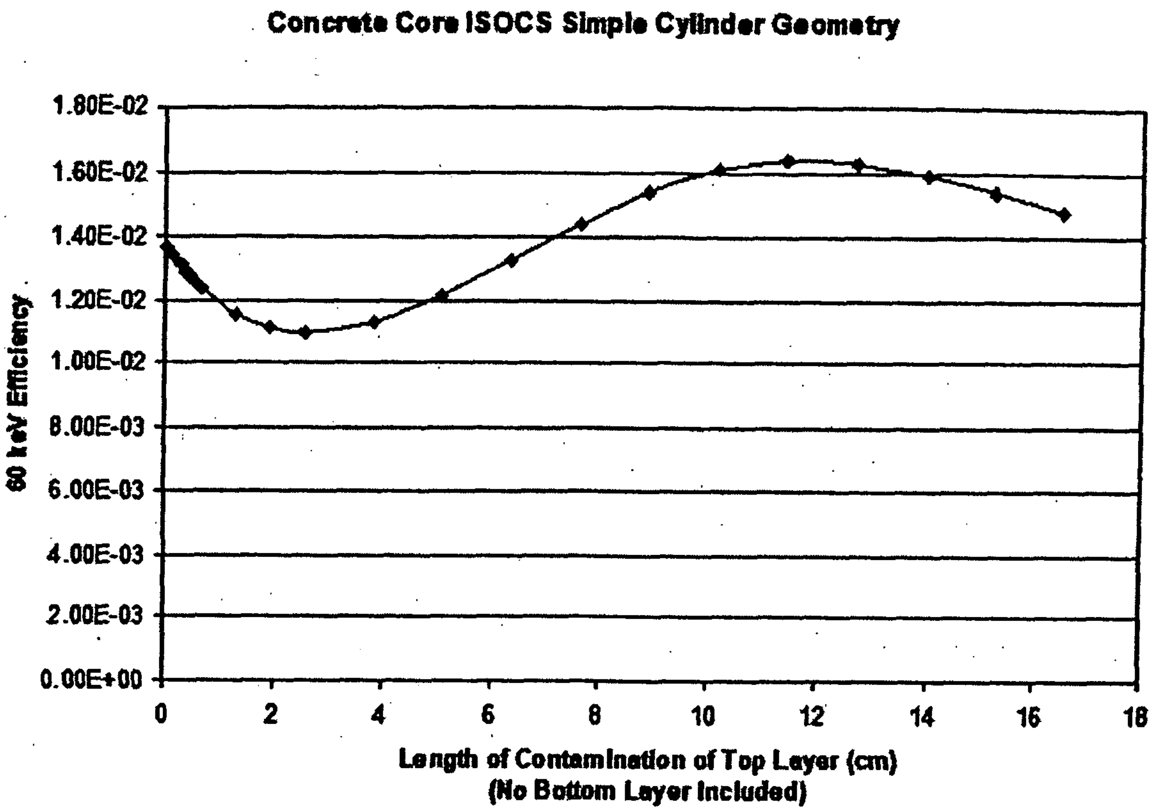

FIGURE 1: Mathematical efficiency calculation results.

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

November 30, 2005

Mr. Ron Bostic
Rocky Flats Project Office
U.S. Department of Energy
10808 Hwy 93, Unit A
Golden, CO 80403

**SUBJECT: CONTRACT NO. DE-AC05-00OR22750
FINAL REPORT—VERIFICATION SURVEY OF THE BUILDING 776/777 CLOSURE PROJECT, ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN, COLORADO**

Dear Mr. Bostic:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has prepared the final report for the Building 776/777 Closure Project at the Rocky Flats Environmental Technology Site in Golden, Colorado. Comments provided on the draft report have been incorporated into the final report.

Please contact me at (865) 576-5321 or Scott Kirk at (865) 574-0685 should you need additional information.

Sincerely,

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IN-PROCESS VERIFICATION SURVEY
OF THE
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Prepared by

P. C. Weaver

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Prepared for the
Department of Energy

FINAL REPORT

NOVEMBER 2005

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GOLDEN COLORADO

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ABBREVIATIONS AND ACRONYMS

ALARA	as low as reasonably achievable
ASCV	average surface contamination value
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOP	decommissioning operations plan
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQO	data quality objectives
ESSAP	Environmental Survey and Site Assessment Program
FIDLER	field instrument for the detection of low-energy radiation
ITP	Intercomparison Testing Program
IV	independent verification
IVPP	independent verification project plan
IVT	independent verification team
JHA	job hazard analysis
KeV	Kilo electron Volt
K-H	Kaiser-Hill Company
m	meter
m^2	square meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
mrem/yr	millirem per year
nCi/g	nanocuries per gram
NIST	National Institute of Science and Technology
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
PSP	project specific plan
PDS	pre-demolition survey
RFETS	Rocky Flats Environmental Technology Site
RFPO	Rocky Flats Project Office
SU	survey unit
TSA	total surface activity
WGP	weapons grade plutonium
ZnS	zinc sulfide

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INTRODUCTION

The Atomic Energy Commission, predecessor agency to the U.S. Department of Energy (DOE), selected the Rocky Flats site in 1951 to serve as a nuclear weapons component production facility. Production began in 1952 on both nuclear and non-nuclear components with the plutonium pits being the key component. Uranium and beryllium were also utilized in the production of various components and processes. Operations continued until 1989 when environmental and safety concerns temporarily halted operations. There were over 700 structures, such as process and support buildings, that were involved in the site's mission. In 1993, the production mission was permanently ended and a new mission to cleanup the site by 2006 was initiated. The site has since been renamed as the Rocky Flats Environmental Technology Site (RFETS).

Kaiser-Hill Company, L.L.C. (K-H), is the Department of Energy (DOE) contractor responsible for closure of the Rocky Flats Environmental Technology Site Closure Project (RFETS) by the year 2006. To meet the closure goal, K-H performed remediation, when necessary and feasible, conducted pre-demolition surveys (PDS), implemented independent verification, and finally demolished buildings and structures at the site.

K-H prepared a Decommissioning Operations Plan (DOP) to address the specific issues associated with the removal of Buildings 776 and 777. Because of a major contamination event that occurred in Buildings 776 and 777, K-H developed a plan based on the as low as reasonably achievable (ALARA) principle to control releases to the environment and doses to the workers during building demolition. The ALARA goals were achieved by using a combination of decontamination techniques that included component removal, wiping, washing with various cleaning solutions, concrete shaving, scabbling, etc. Building surfaces that could not be reasonably decontaminated were sealed with fixatives or encapsulants designed to minimize residual contamination releases. Characterization surveys conducted by K-H provided the input data to the radiological pathway analysis model designed to evaluate potential airborne releases and resulting doses to the workers and general public. The DOE's Rocky Flats Project Office (RFPO) requested the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) to provide independent verification survey activities for the Building 776/777 Closure Project.

SITE DESCRIPTION AND BUILDING HISTORY

The RFETS is located approximately 16 miles northwest of Denver, Colorado on State Highway 93 and Cactus Road. RFETS occupies approximately 385 acres within the 6,000-acre reservation site owned by DOE (Figure 1). The site was divided into two major operable units: the Industrial Area and the Buffer Zone with all nuclear facilities within the boundaries of the Industrial Area (Figure 2).

Construction on Building 776/777 began in the 1950's. The Building 776/777 complex was a two-story structure with a partial basement and common wall that separated Buildings 776 and 777 (Figure 3). A tunnel on the northeast corner of Building 776 connected Building 771. The first floor of Building 776 and 777 had an area of approximately 135,000 ft. The second floor and basement had surface areas of 88,000 ft^2 and 1,600 ft^2, respectively, with a total surface area for the entire facility measuring 224,600 ft^2 that also include numerous additions built since original building construction (K-H 2003a).

Building 776 served as the primary manufacturing facility for plutonium (Pu) weapons components and housed the Pu foundry and fabrication operations from 1958 until 1969. Building 777's main function was for parts assembly. Buildings 776/777 contained an extensive glove box network supporting various Pu operations (K-H 2003a).

In 1969, the majority of the foundry and fabrication operations were transferred to Building 707 after a major fire resulted in gross radiological contamination of Building 776/777. The operating areas of the first floor were highly contaminated and the entire second floor was moderately contaminated with airborne contamination that filtered through the floors and the walls. Office areas in Building 776/777 were moderately contaminated on the floors from infiltration of fire suppression water. The roof was moderately contaminated in three areas; two were localized around vent penetrations and the third involved an area from around an exhaust duct to the edge of the roof. After the fire, the majority of the glove boxes were removed from Building 776 and the large room that contained these glove boxes was compartmentalized into several areas that were separated by physical barriers to confine radioactive material releases. Upon completion of initial cleanup activities, limited production operations were resumed. However, the main focus of activity for the building was shifted to waste and residue handling, disassembly of retired weapons components and other special projects. Operations in Building 777 included machining, product assembly and disassembly, testing and inspections of projects, and support operations. These operations continued until production was curtailed in 1989 (K-H 2003a).

INDEPENDENT VERIFICATION OBJECTIVES

The objectives of the verification were to implement the data quality objective (DQO) process, as defined in the Independent Verification Program Plan (IVPP). This effort was needed to evaluate the pre-demolition radiological condition relative to the 776/777 Closure Project structures against the defined building-specific residual contamination criteria (ORISE 2004a). The IVT was to assure that the source term data were adequate for demonstrating that the project's characterization survey objectives were met. Specifically, the IVT verified the final characterization and pre-demolition program implemented by the decommissioning and decontamination (D&D) contractor.

To expedite the D&D process, the IVT coordinated and worked with the project to conduct Type B independent verification surveys, in tandem with PDS rather than at the completion of final survey and reporting activities. In-process reviews followed the applicable lines of inquiry, as outlined in Appendix A of the IVPP, as appropriate. Type B verifications were conducted per the IVPP, and as described in the Survey Procedures section of this document.

DOCUMENT REVIEWS

The document reviews evaluated the potential outcome of the surveys based on the review of significant documentation and procedure implementation. This included reviewing the PDS plan and data, including the methodology used to calculate the average surface contamination values (ASCV), procedures for the selection, calibration, and use of survey instrumentation, and adequacy of survey and analytical planning and procedures (K-H 2002, 2003a and b, and DOE 2005). The reviews allowed for an in-depth evaluation of the adequacy and appropriateness of the D&D contractor's approach relative to the DQOs.

TYPE B VERIFICATION SURVEYS

ESSAP conducted in-process Type B verification surveys in accordance with a project-specific plan (PSP) submitted to and approved by DOE for Buildings 776/777 (ORISE 2004b). Surveys were performed on the following dates: April 26 to April 28, 2004; August 18 to August 19, 2004; and February 7 to February 9, 2005. ESSAP concentrated in-process survey efforts in areas having the greatest potential for contamination. The primary objective of the IV evaluation was to validate the K-H survey methodology developed to determine the final building ASCV. Measurements provided by the IVT served to corroborate measurement findings provided by K-H as well as provide assurance that the accuracy of survey methodology was maintained throughout the duration of the project. All survey activities were performed in accordance with the ORISE/ESSAP Survey Procedures Manual and the Quality Assurance Manual (ORISE 2004c and d).

REFERENCE GRID

The IVT used the survey unit (SU) reference system established by the D&D contractor to identify measurement and sampling locations. Measurement and any sampling locations were also documented on detailed survey maps and/or photographic records.

SURFACE SCANS

In an effort to evaluate the effectiveness of the scanning methodology implemented by K-H, where the detector was set at a height 30 cm from the floor, ESSAP performed surface scans. ESSAP used source-to-detector distance of 1 cm above the measured surface. Surface scans were performed over 70 to 100 percent of accessible floor area, up to five percent of the lower walls (up to 2 meters), and approximately one percent on upper surfaces (in selected SUs). Particular attention was given to visible cracks and joints in the floor and on walls, ledges, drains, and horizontal surfaces where material could have accumulated. Locations of elevated radiation levels, identified by ESSAP, that were at least an order of magnitude or greater than the K-H results were brought to the attention of DOE and K-H for further investigation.

Gamma Surface Activity Measurements

The IVT and K-H performed side-by-side (i.e., at the same location) gamma surface measurements utilizing the similar detection capabilities. The basic field instrument for the detection of low-energy radiation (FIDLER) was used in order to provide for consistency in reporting of field data with slight variations in detector operational and physical set-ups. The side-by-side approach allowed for a direct data comparison and provided a means to identify instrument biases between K-H and the IVT.

Eighteen of the 41 SUs selected by the IVT for Type B verification was either generated randomly, on a judgmental basis, or as requested by DOE. The IVT collected 297 gamma surface measurements in 18 SUs in Buildings 776 and 777 (Figures 4 to 23).

Miscellaneous Samples

Limited sampling was performed to determine the distribution of contamination entrained in the matrix of the concrete slab of Building 777. Concrete core samples were collected from cracks and existing expansion joints having elevated gamma radioactivity in SU 776023 (Figure 13). Eight, three-inch diameter concrete core samples, one sample of original epoxy media, and one surface sample of a concrete block were collected for analysis.

DATA ANALYSIS AND INTERPRETATION

Gamma scan data were reported in counts per minute (cpm). Gamma surface measurements were converted into units of disintegrations per minute per one hundred square centimeters (dpm/100 cm^2) for direct comparison to K-H data. For purposes of consistency in reporting any findings, the same assumptions utilized by K-H for data reduction were applied to ESSAP's data after review and verification by ESSAP.

Radiological sample analyses were performed at the ORISE/ESSAP laboratory in Oak Ridge, Tennessee in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 2004h). Concrete cores samples were analyzed by gamma and/or alpha spectroscopy and reported in units of picocuries per gram (pCi/g) and then converted to dpm/100 cm^2 as appropriate. Details on the input parameter evaluation are included the ESSAP interim reports (ORISE 2004f and 2005a).

Data were compared to the K-H field measurements and against the final ASCV limits when averaged over the entire building, for weapons grade plutonium (WGP). The ASCV limits are as follows (K-H 2003b):

Average Surface Contamination Value

[illegible]	[illegible]	[illegible]
ASCV	45,500 $\mu Ci/m^2$	455 $\mu Ci/m^2$
Surface Activity (1)	1 E9 dpm/100 cm^2	1 E7 dpm/100 cm^2

(1) Value that equates to the ASCV as calculated by ORISE.

FINDINGS AND RESULTS

DOCUMENT REVIEW

Specific comments were provided following the reviews of the final survey summary reports for Areas I through VII (ORISE 2004i and 2005b). Overall, the reviews indicated that the PDS process was being conducted in accordance with the DQOs and associated procedures specified in the DOP.

SURFACE SCANS

Surface scans identified several areas that K-H had not identified and accounted for in Building 777, in particular, SUs 776015, 776018, 776021, and 776023. These locations were specific to areas with cracks on the floor and at floor/wall intersections.

Gamma Surface Activity Measurements

The results of gamma surface comparison measurements are presented in Tables 1 to 18 with the exception of SUs 776002, 776011, 776012, 776019, 776035, and 776041. Qualitative data for the aforementioned SUs were provided by K-H to ESSAP. However, specific instrument variables to convert the data from count rate to activity were not provided to ESSAP. The qualitative data was within an order of magnitude of the ESSAP qualitative data, providing an indicator that the K-H data were representative of actual radiological levels.

During the February, 2005, survey effort, one of the K-H detectors malfunctioned. The malfunction was attributable to an issue with the data logger coupled to the detector. However, additional measurements were collected by K-H at the same surface measurement locations where the detector malfunctioned. An in-depth review of the field data provided to ESSAP did not indicate that the malfunction was systematic in nature, and did not appear to affect the reported count rate. The reported data were within an order of magnitude of the ESSAP data, and therefore were not flagged for further action.

Several locations of elevated activity were identified by ESSAP that were not previously identified by K-H. The maximum observed activity identified by ESSAP was 71,000,000 dpm/100 cm^2 at SU 776012. Areas with notably high activity were also found in SUs 776002, 776011, 776018, 776019, 776023, and 776041.

A large number of negative values were noted for several survey units, including 776002, 776004, 776029, 776032, and 776043 (Tables 1, 2, 13, 14, and 18). This is due to the fact that ESSAP established material-specific backgrounds in Building 777 (at the same background reference areas as K-H) and applied the background values to the survey units in Building 776. A review of the actual K-H data also indicates an excessive number of net negative results. However, this is not apparent in the data tables because K-H reported the MDC value when the net result was less than MDC. All data indicate that a Building 776-specific background reference area would have been desirable. However, this was not practical due to the extent of contamination in Building 776. In summary, the K-H and ESSAP net results were comparable;

therefore it is not expected that the overall conclusion for these specific survey units would have changed.

ESSAP suspects that the calibration method used by K-H explains why these areas of elevated activity may have been overlooked by K-H. K-H used a line source calibration performed at a height of 30 cm to account for total activity of all known joints and intersections. At 30 cm, K-H would account for any hot spots that might be missed. ESSAP's verification scans were performed within a few centimeters of the floor surface, using a swinging motion of the detector which effectively covered a larger surface area.

MISCELLANEOUS SAMPLES

Each core sample and epoxy sample obtained by ESSAP was field screened by K-H prior to being shipped to the ESSAP laboratory for analysis by gamma and alpha spectroscopy. Because of the level of activity in the samples special precautions were needed to safely prepare the cores for analysis. ESSAP operates and maintains an environmental laboratory facility in which only small quantities of activity can be possessed at any given time. Therefore, only two of the eight concrete cores were analyzed to determine the volumetric distribution and the depth of contamination in the concrete matrix. The results of select core sample analysis demonstrated that preferential migration of contamination most likely occurred due to the presence of the expansion joints (Table 9). Furthermore, the results for both inner and outer core samples showed that in both cases the contamination rapidly decreased with depth. This provided the assurance to DOE that the potential for contamination to the underlying soil beneath the concrete slab would be minimally affected.

The analysis also indicated that the average Pu-239 to Am-241 ratio was 4.9. These data indicate that the ratio of 8.1 used by K-H was a conservative value for converting direct measurement results to total activity when multiplying the ratio to the Am-241 activity. A detailed description of the analyses performed and resulting data is presented in a supplemental report provided to DOE (ORISE 2004g).

RECOMMENDATIONS

ESSAP issued an interim report discussing the finding related to the differences in calibration methods between ESSAP and K-H. K-H reviewed the findings and considered the argument to be valid and determined that a combination of both techniques would be used for the remaining PDSs (DOE 2004).

SUMMARY

ESSAP conducted a series of verification surveys that evaluated scan methodology and instrument effectiveness. The verification effort provided assurance to DOE that the methodology implemented by K-H remained at various periods throughout the duration of the PDSs. Overall, the in-process review indicated that the K-H characterization methodology ensured that the final source term in the building satisfied the ALARA goals for demolition. It is ESSAP's position that the approach implemented by K-H was valid.

FIGURES

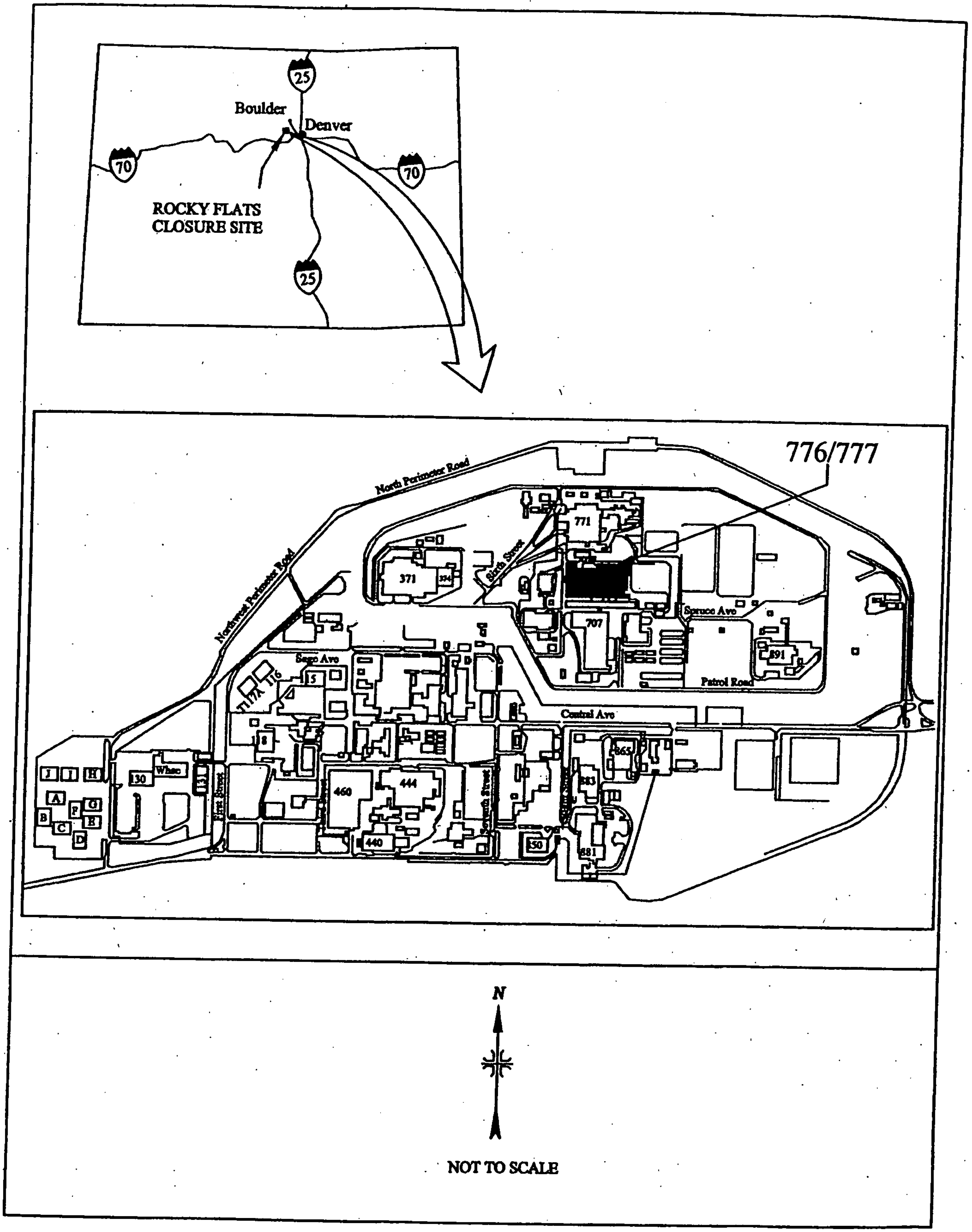

FIGURE 1: Location of the Rocky Flats Closure Site

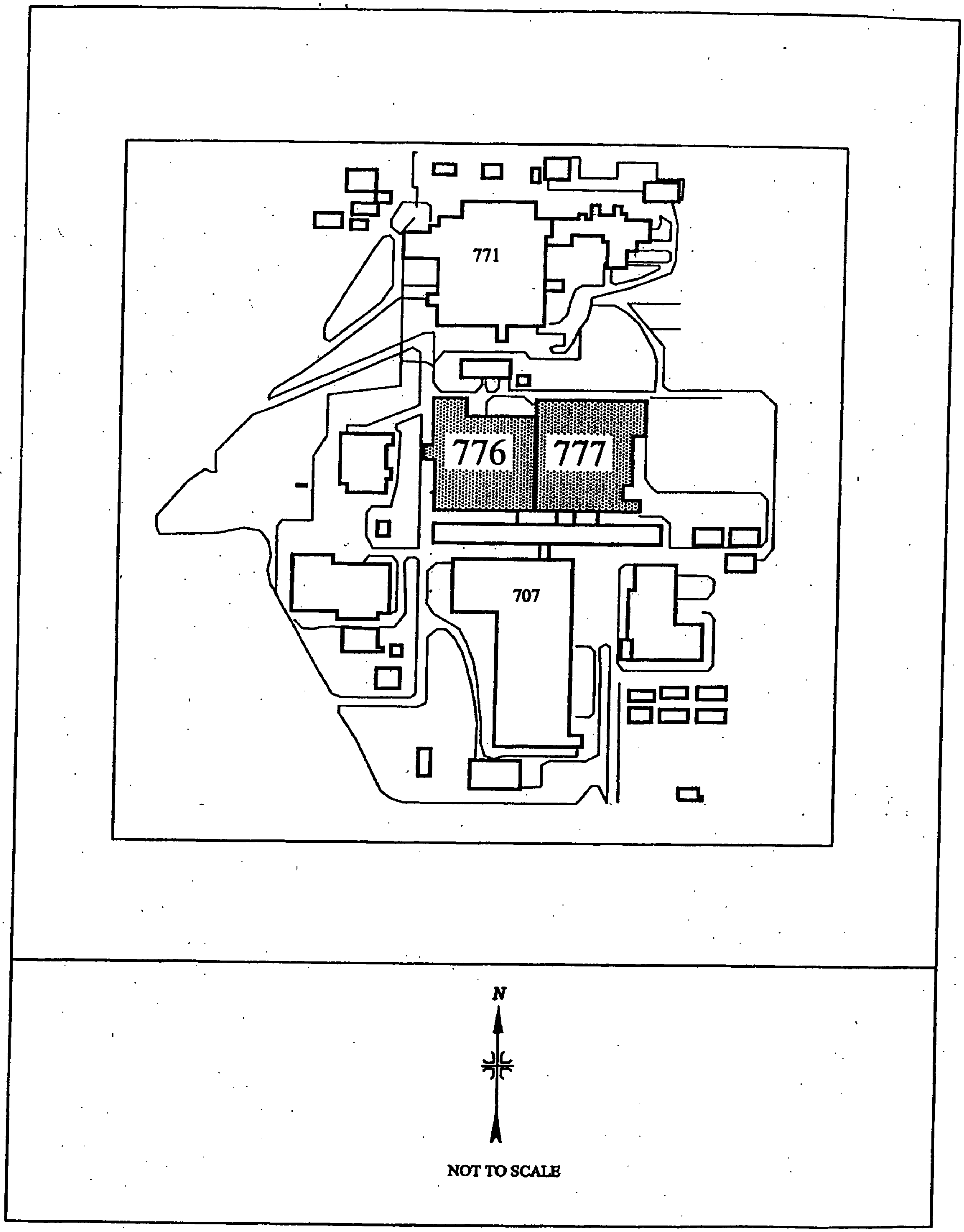

FIGURE 2: Location of Buildings 776/777

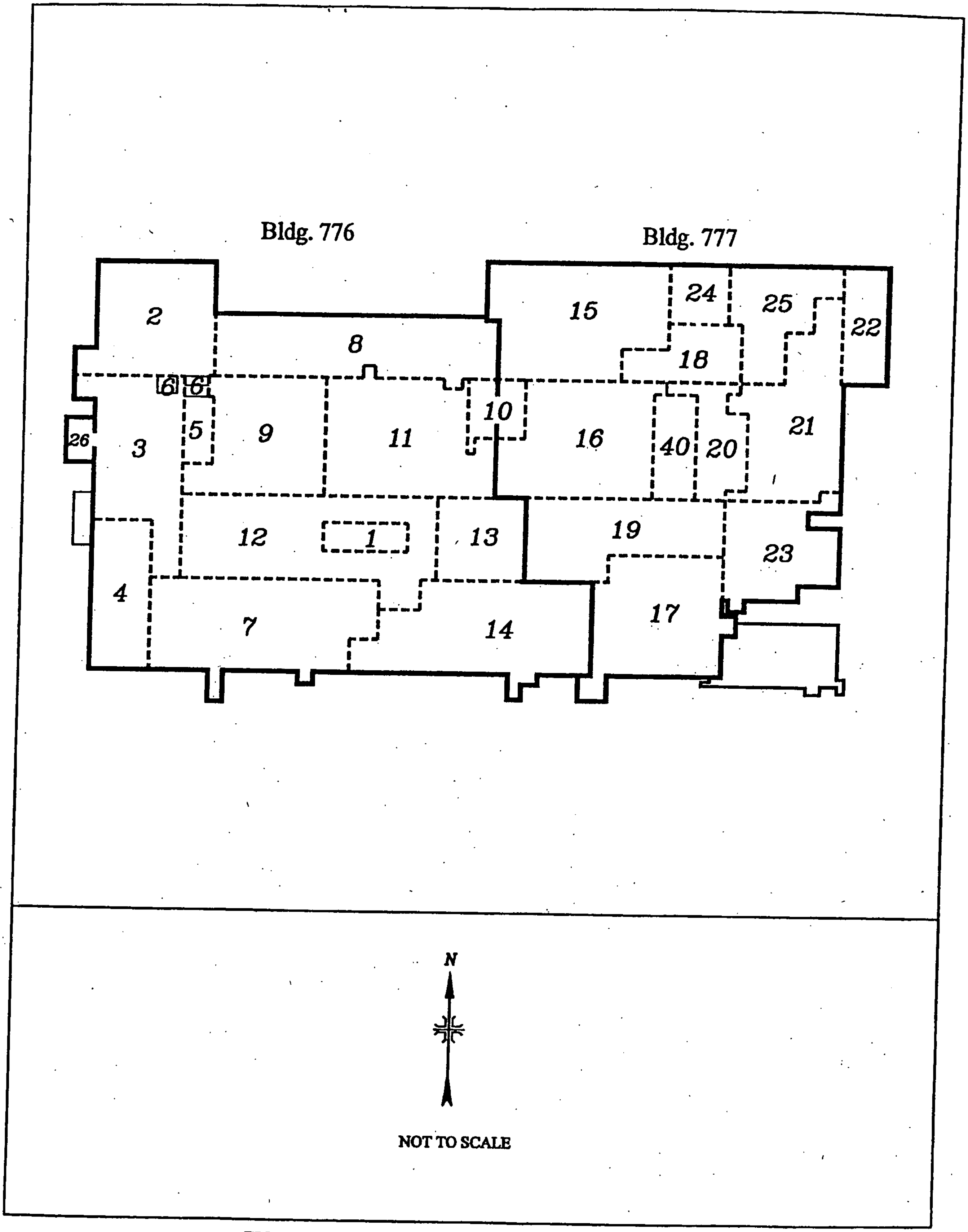

FIGURE 3: Rocky Flats, Building 776/777 - Plot Plan

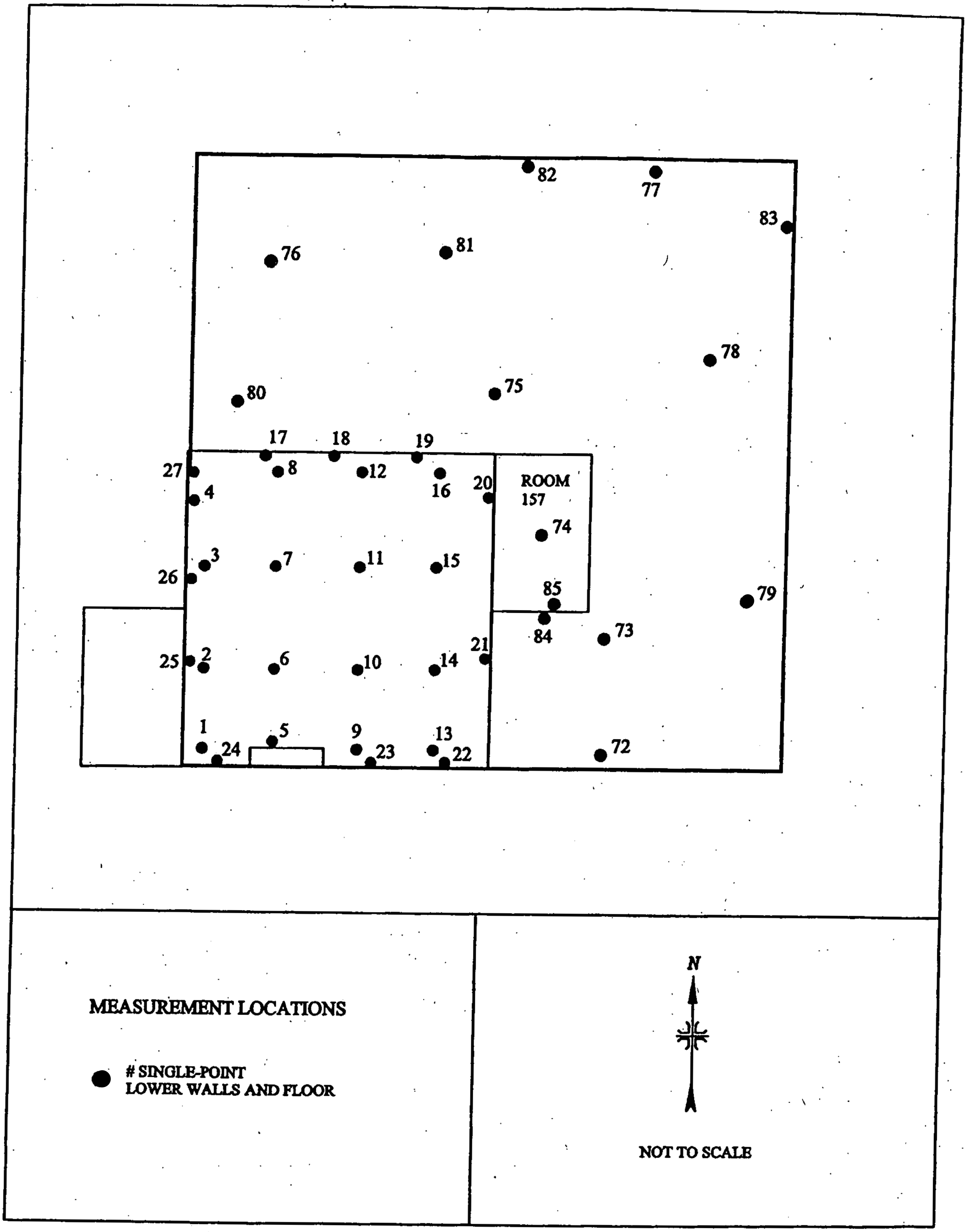

FIGURE 4: Survey Unit 776002 - Measurement Locations

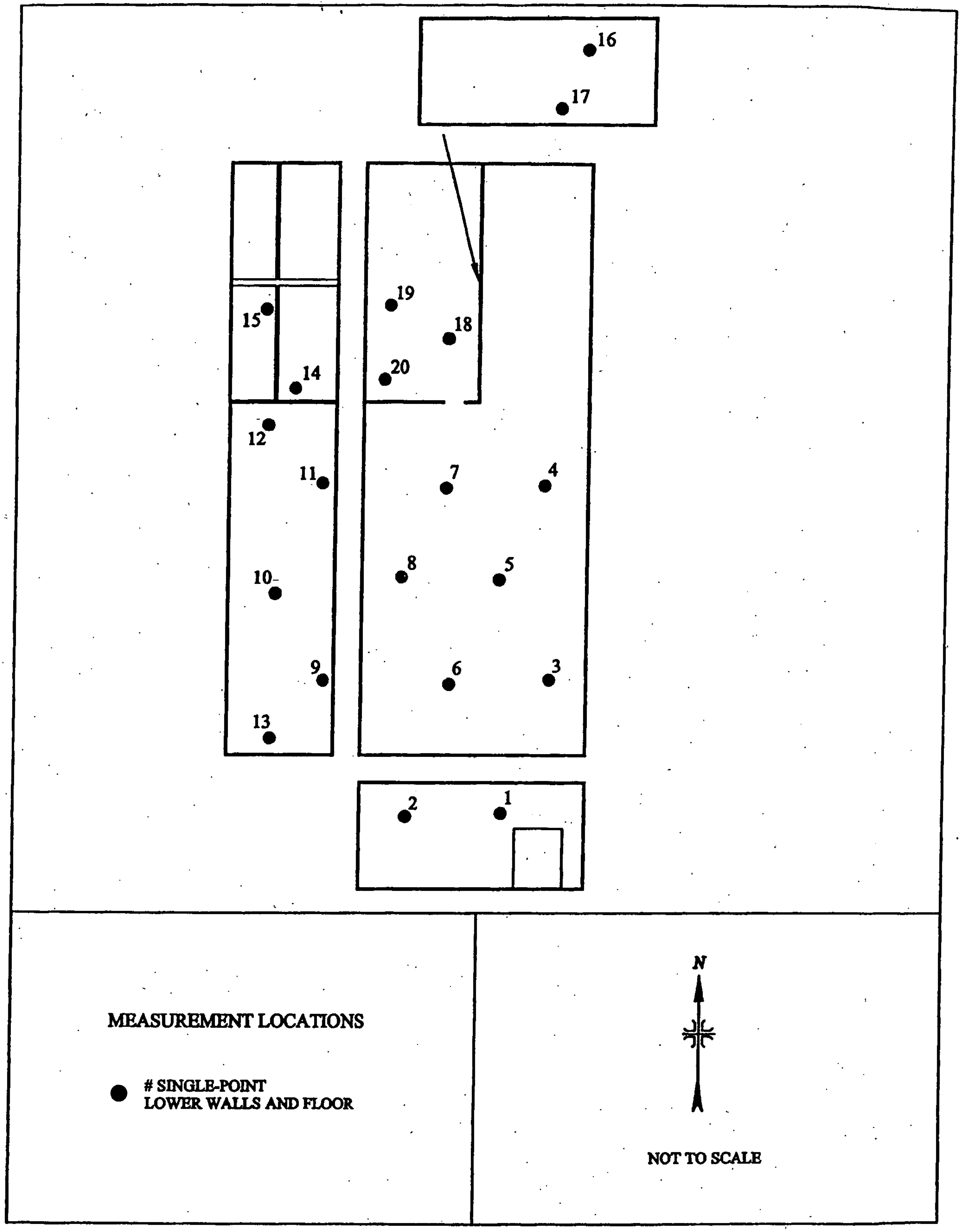

FIGURE 5: Survey Unit 776004 - Measurement Locations

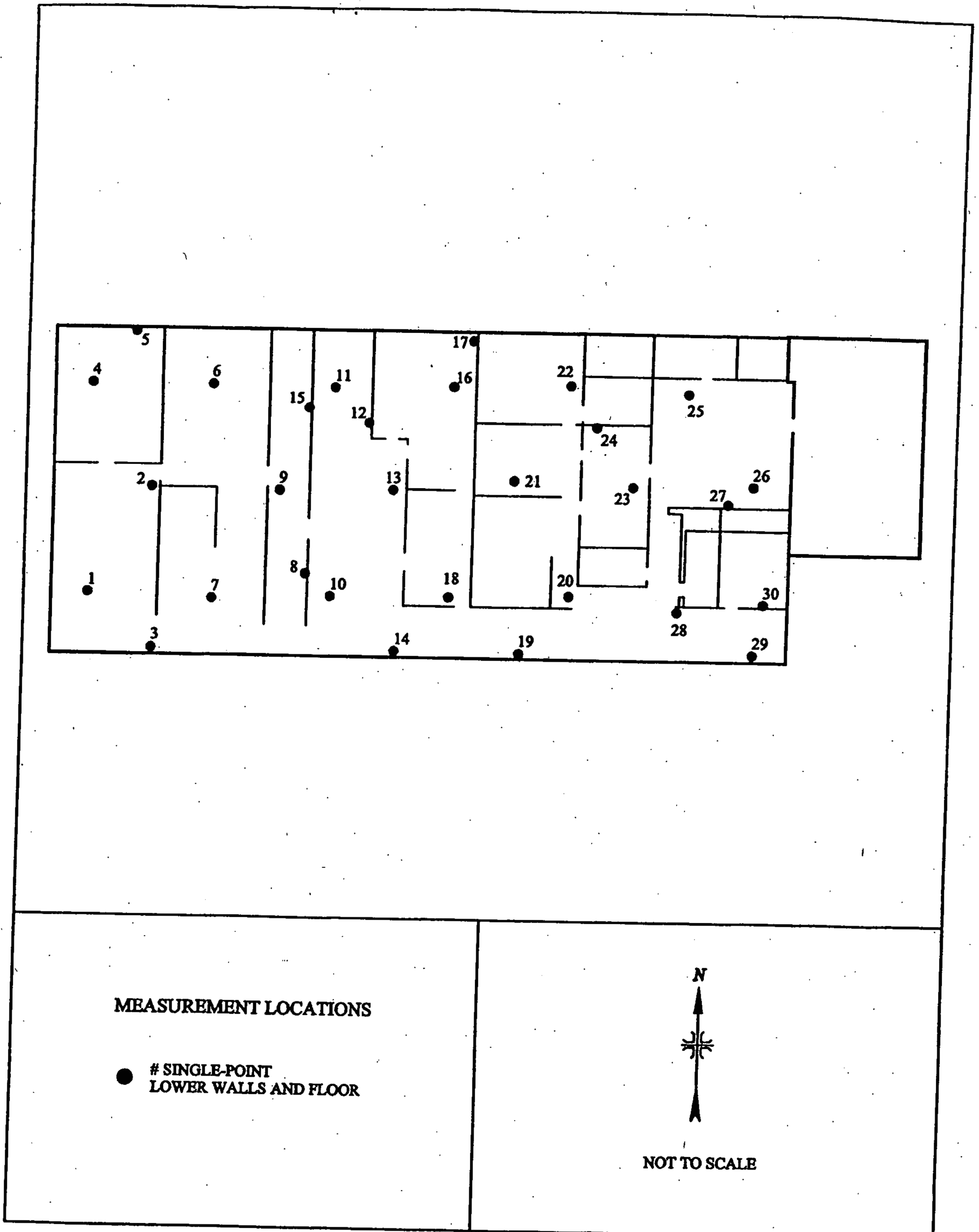

FIGURE 6: Survey Unit 776007 - Measurement Locations

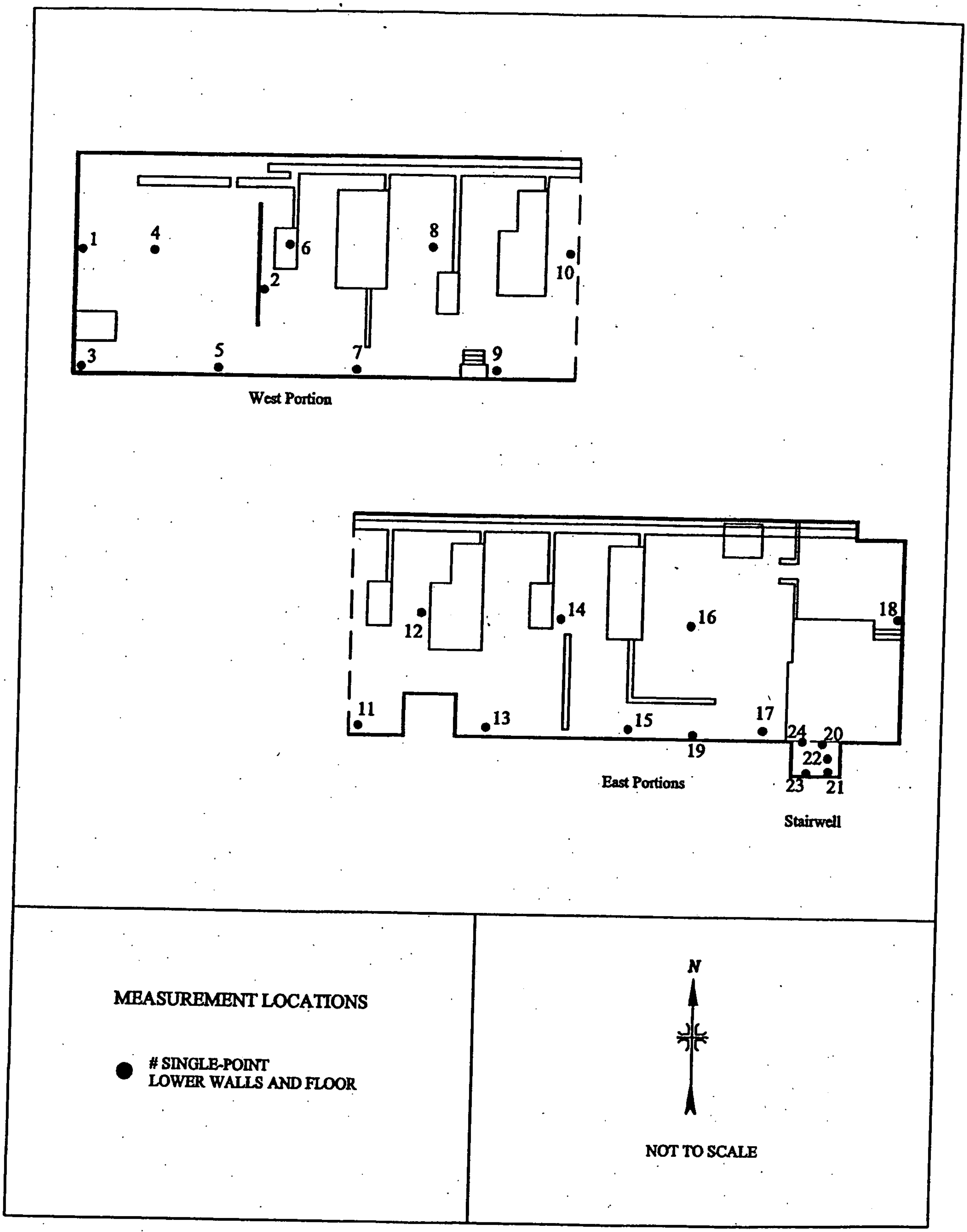

FIGURE 7: Survey Unit 776008 - Measurement Locations

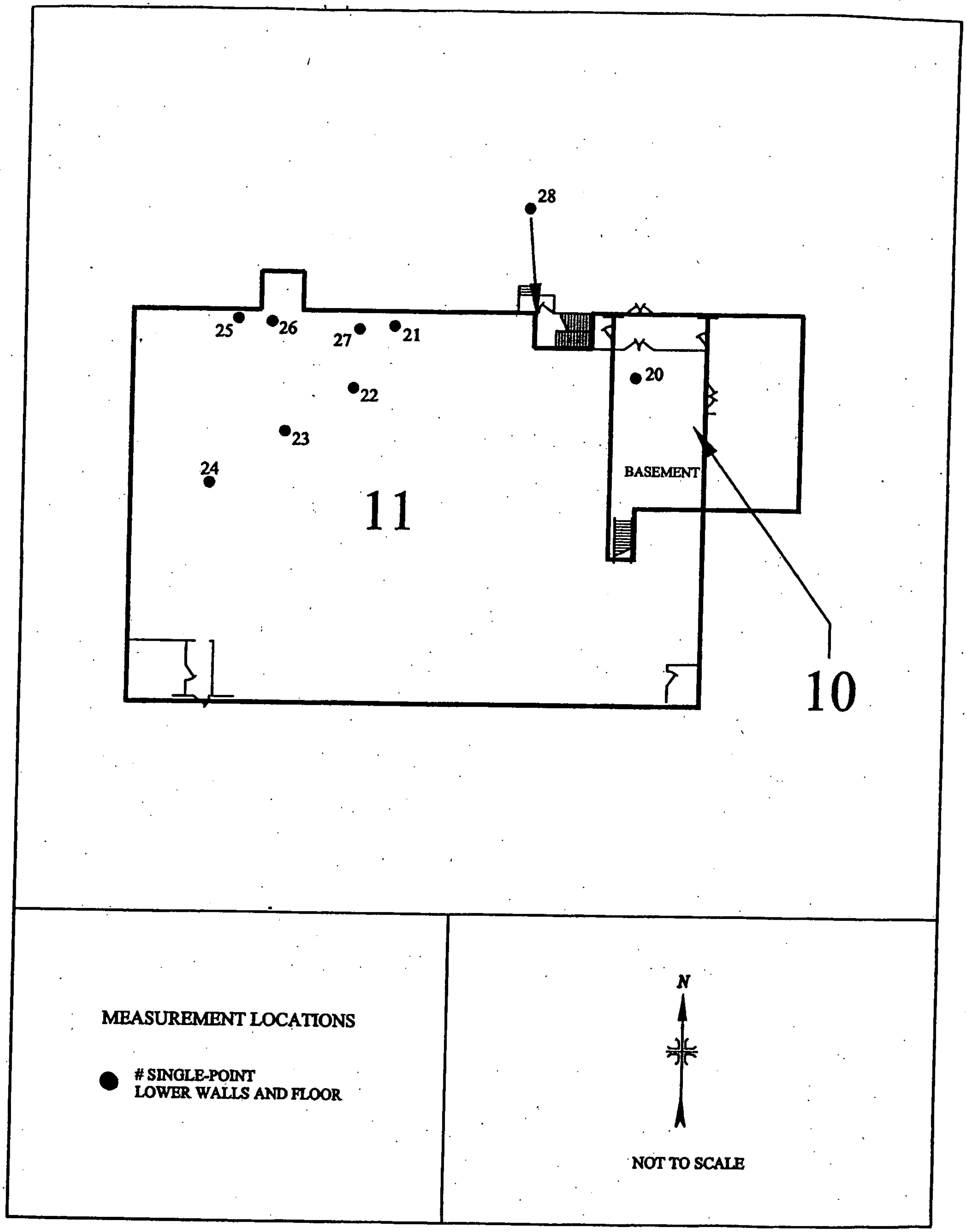

FIGURE 8: Survey Units 776010 and 776011 - Measurement Locations

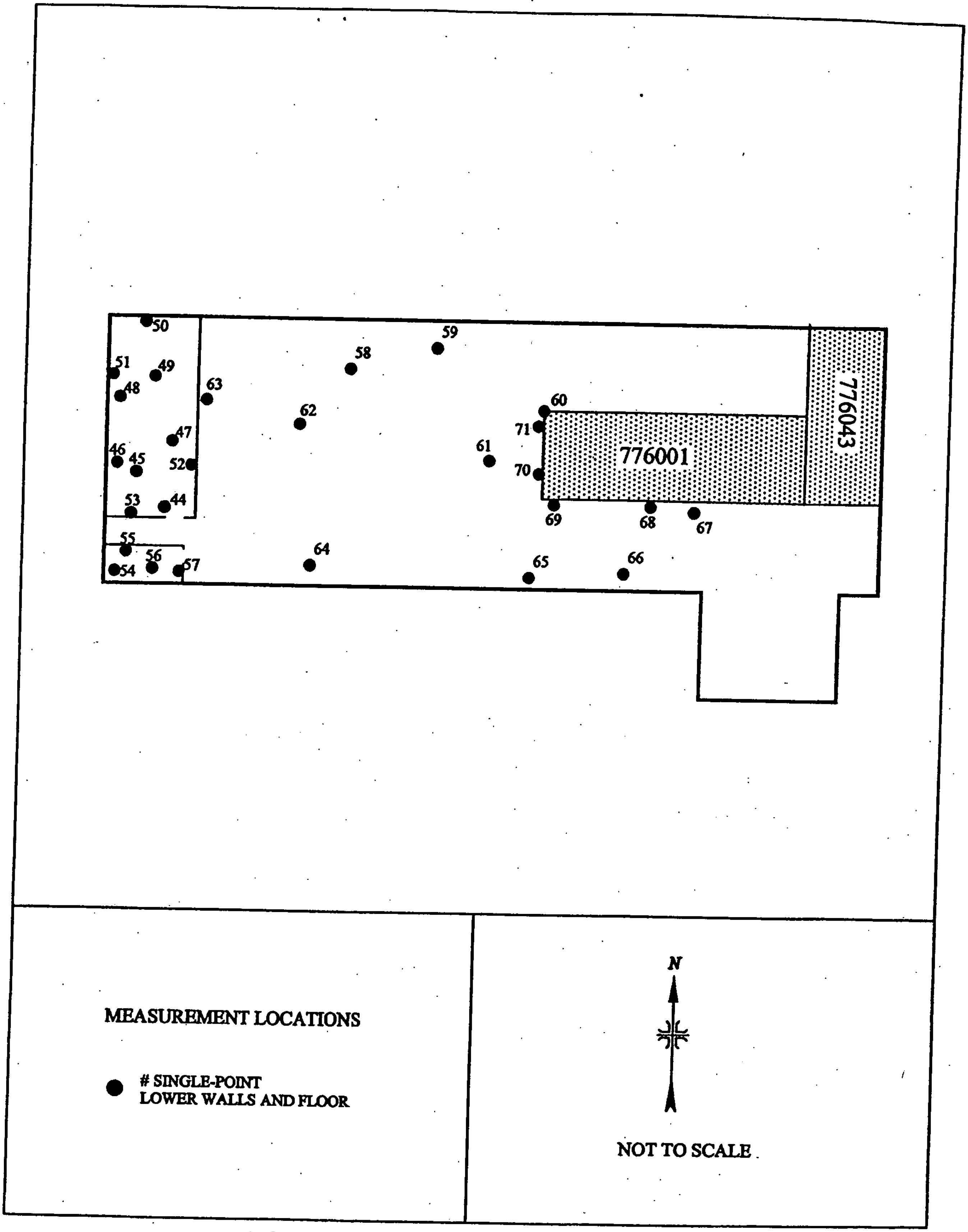

FIGURE 9: Survey Unit 776012 - Measurement Locations

350

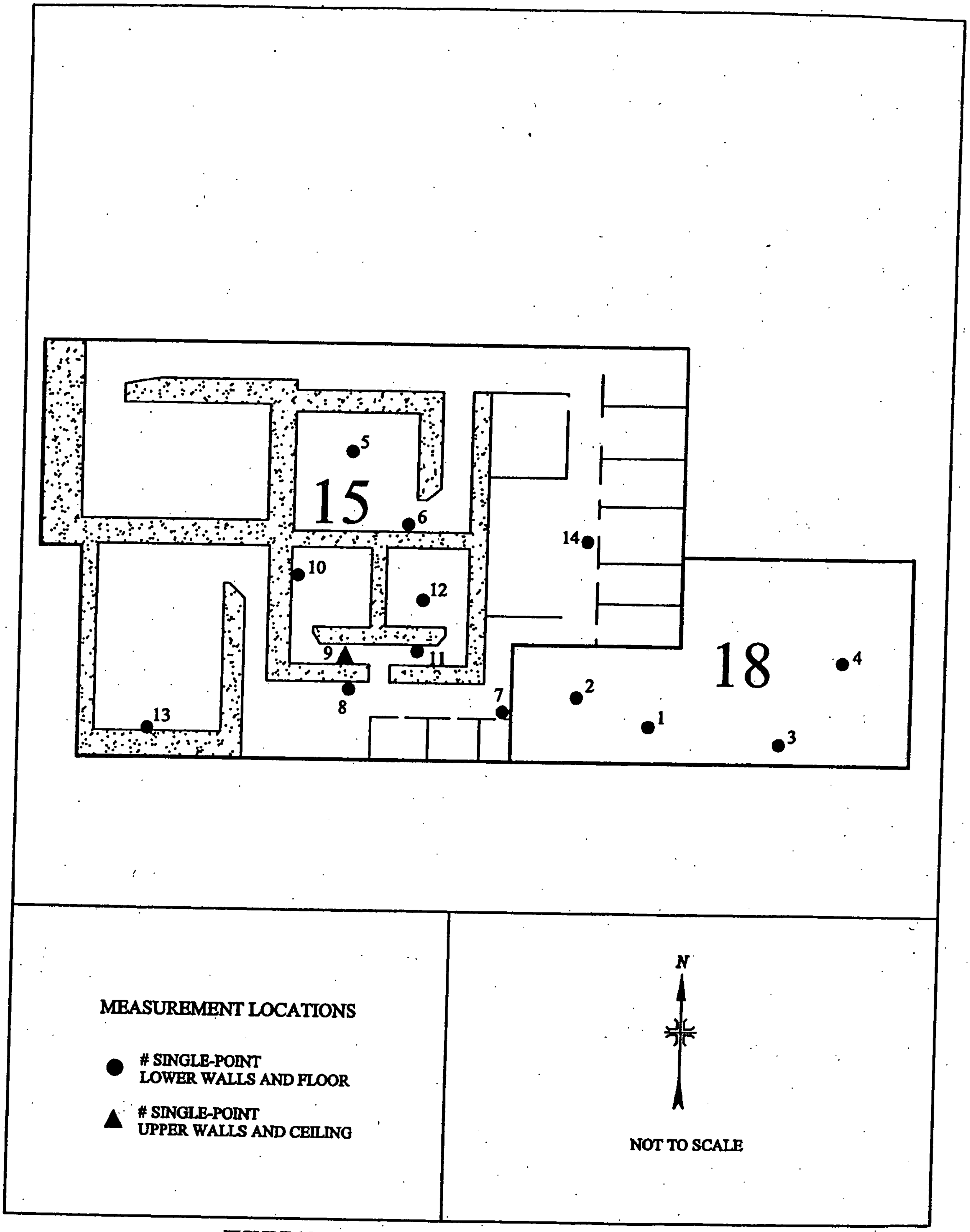

FIGURE 10: Survey Units 776015 and 776018 - Measurement Locations

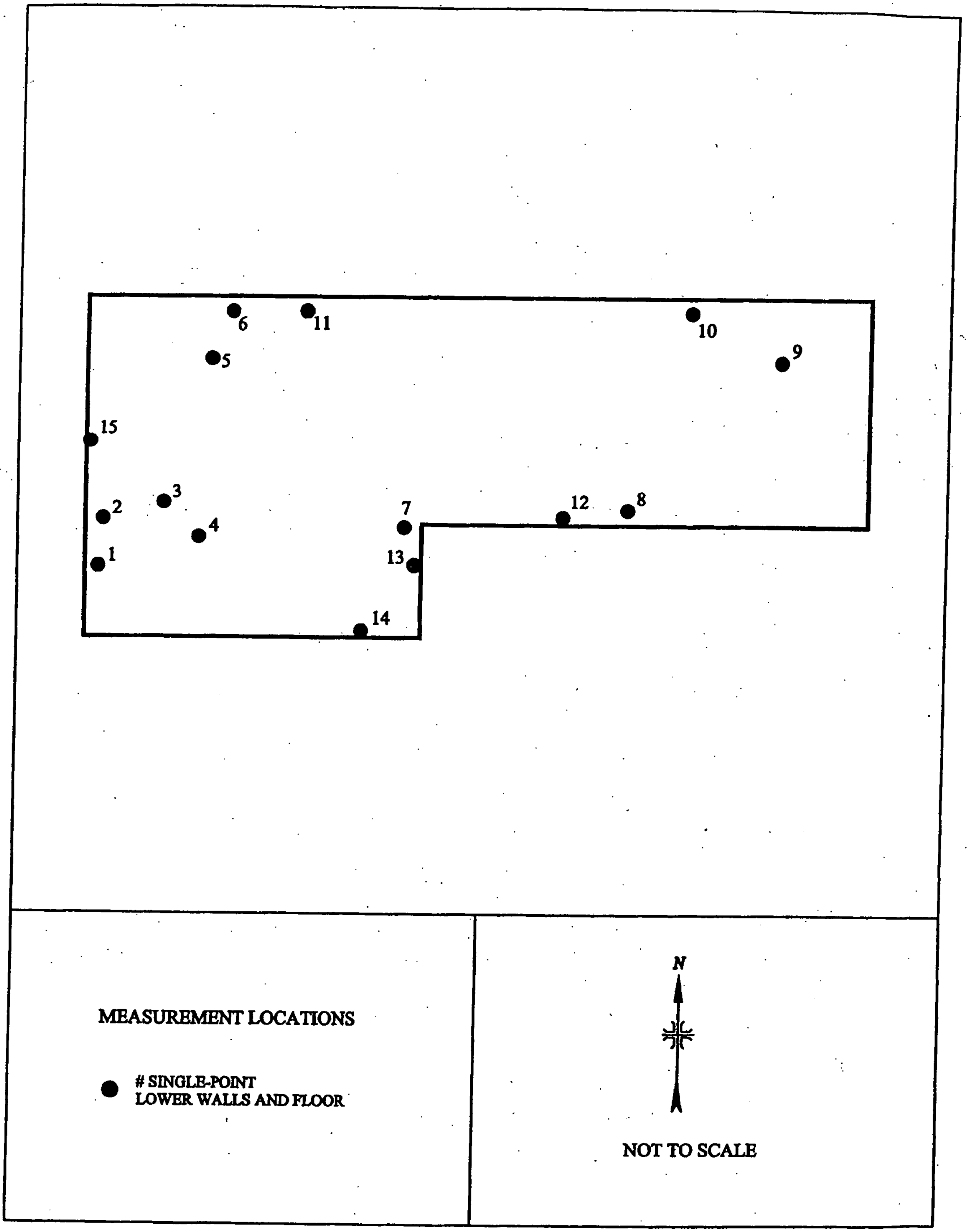

FIGURE 11: Survey Unit 776019 - Measurement Locations

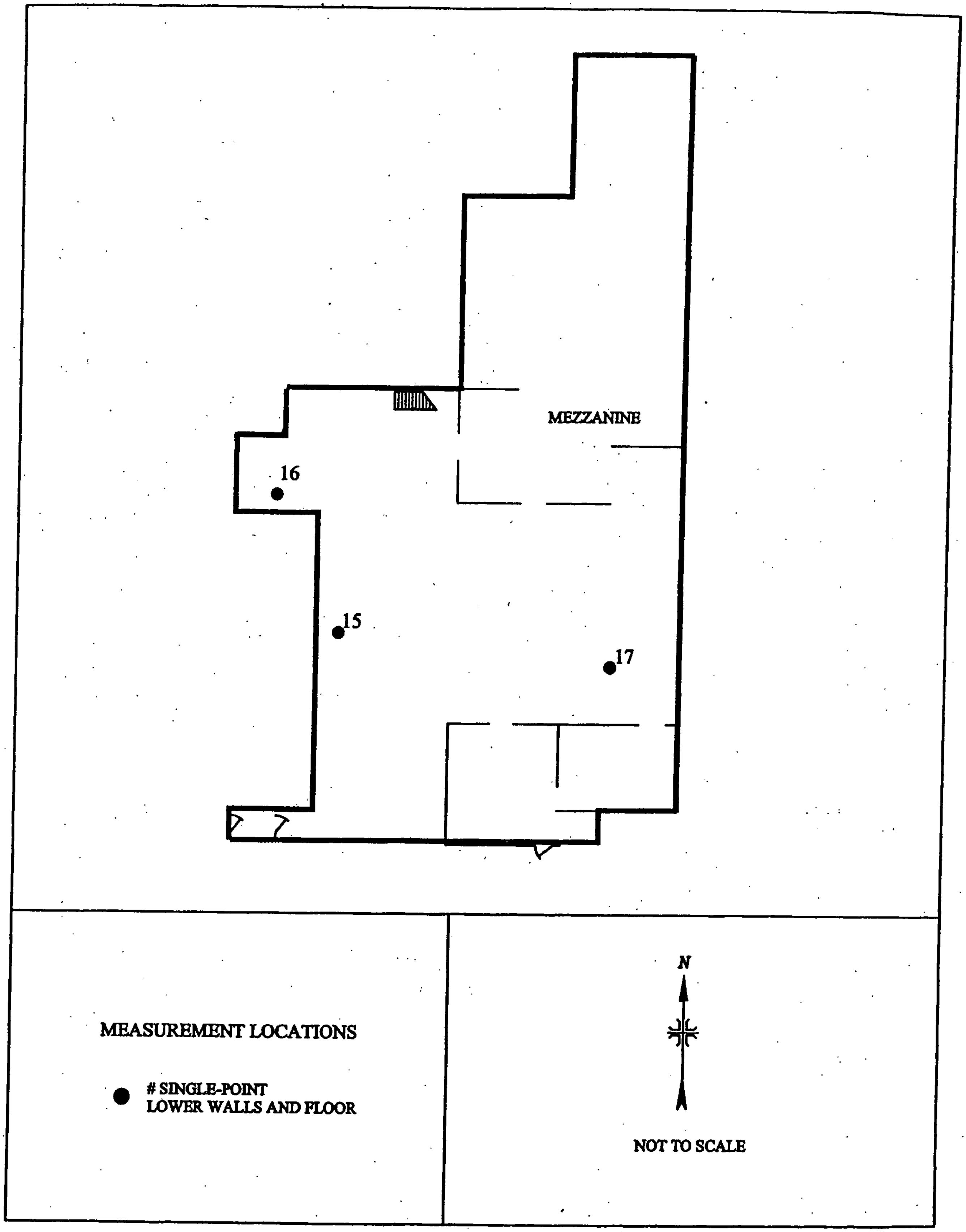

FIGURE 12: Survey Unit 776021 - Measurement Locations

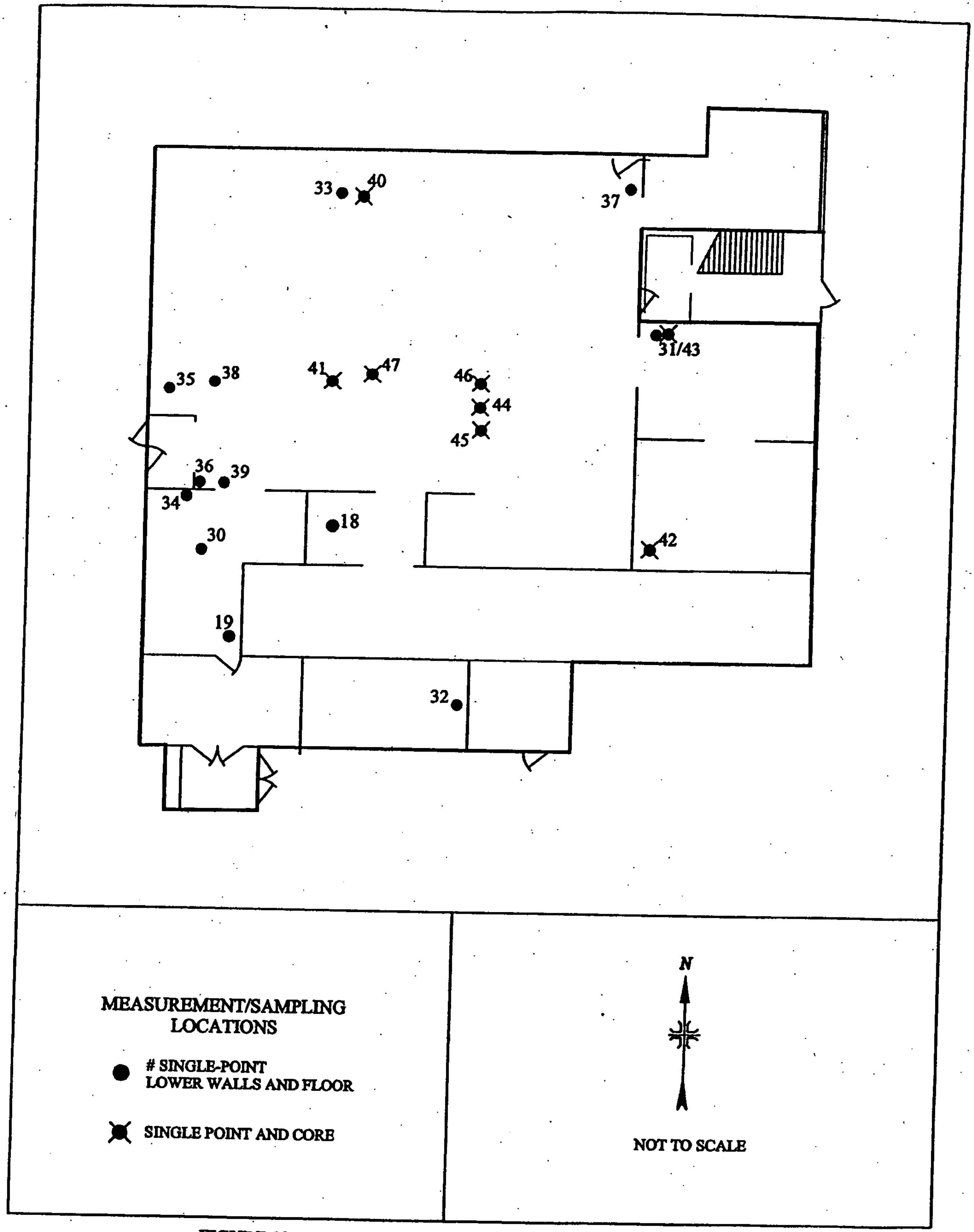

FIGURE 13: Survey Unit 776023 - Measurement and Sampling Locations

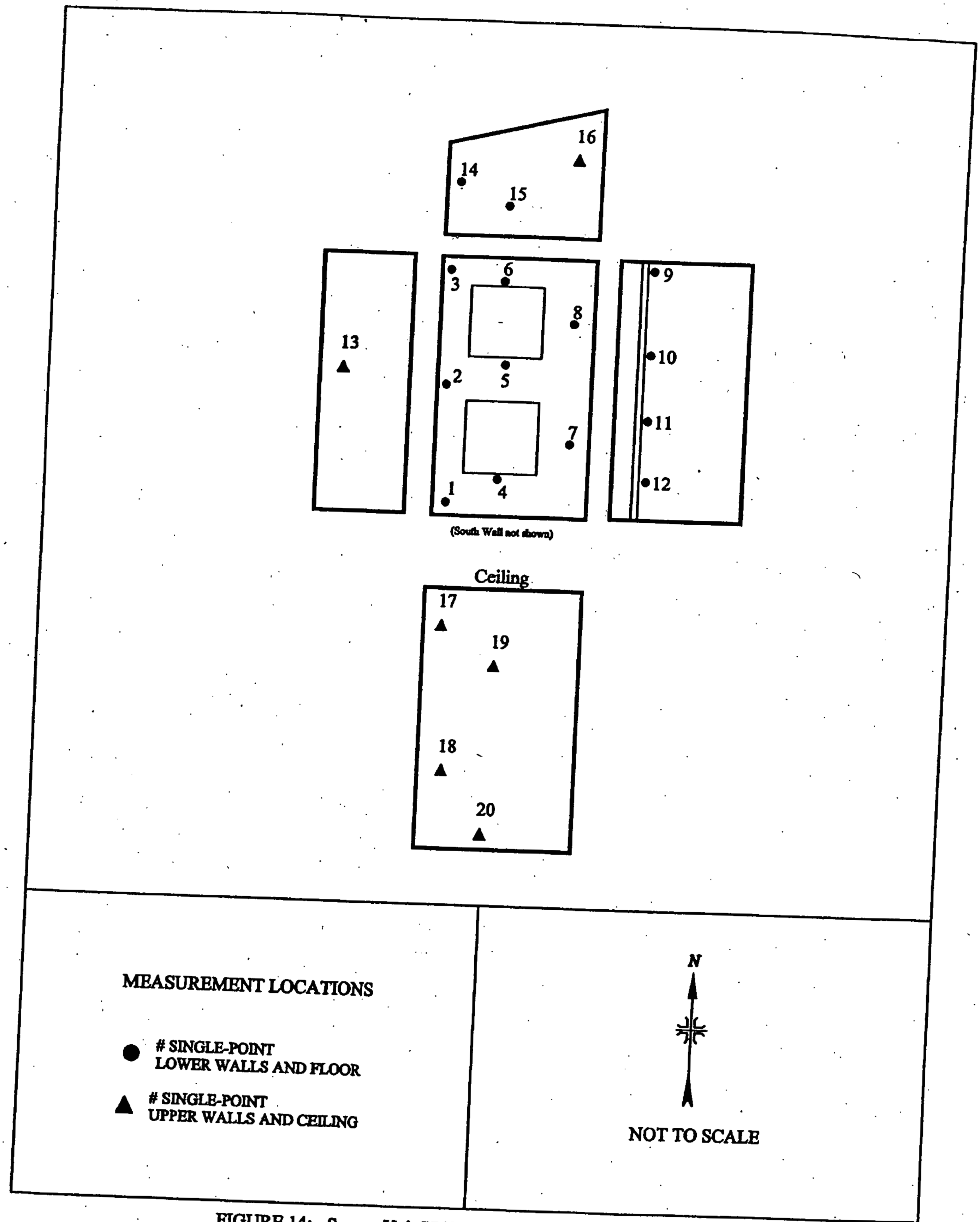

FIGURE 14: Survey Unit 776026 - Measurement Locations

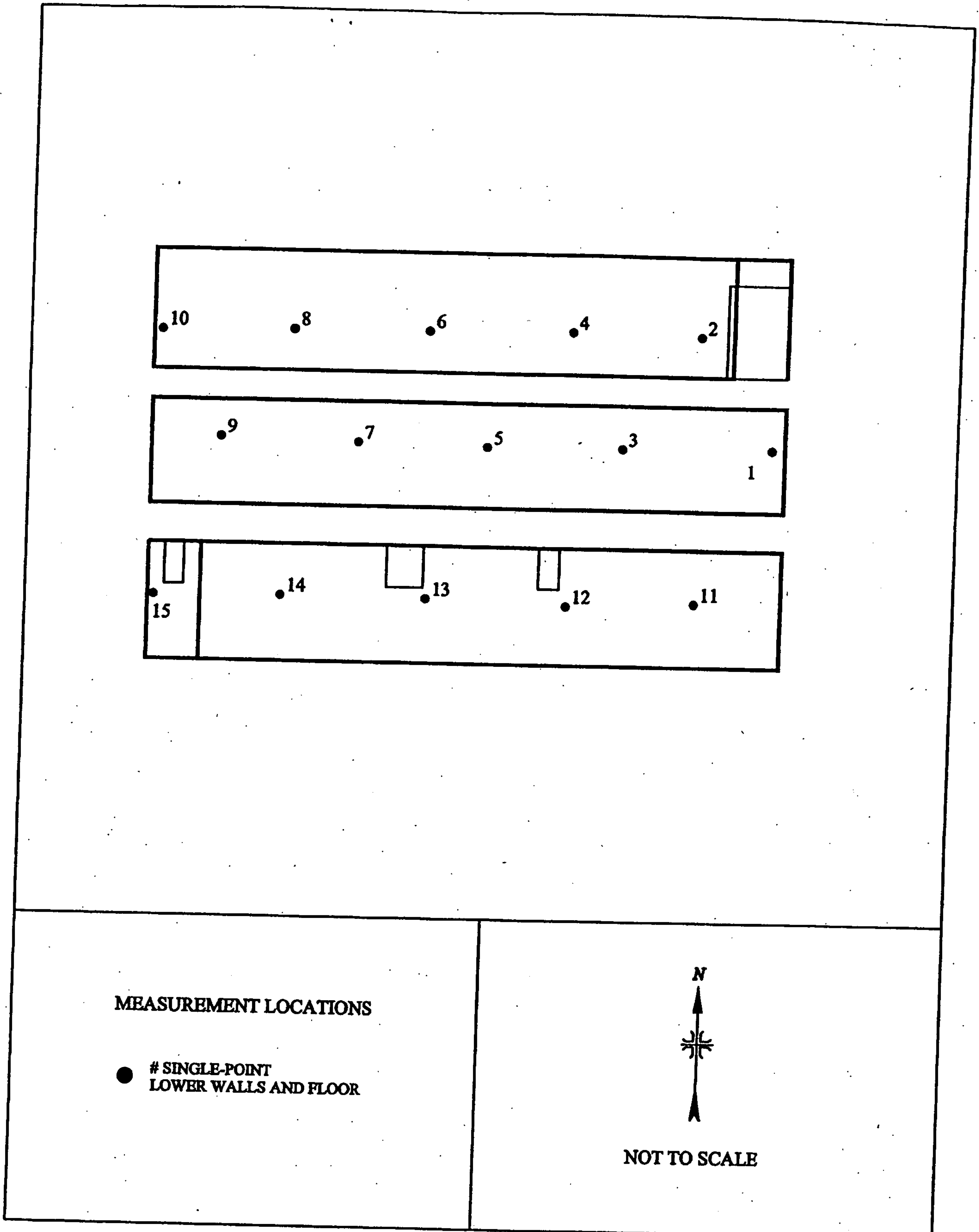

FIGURE 15: Survey Unit 776028, Hall - Measurement Locations

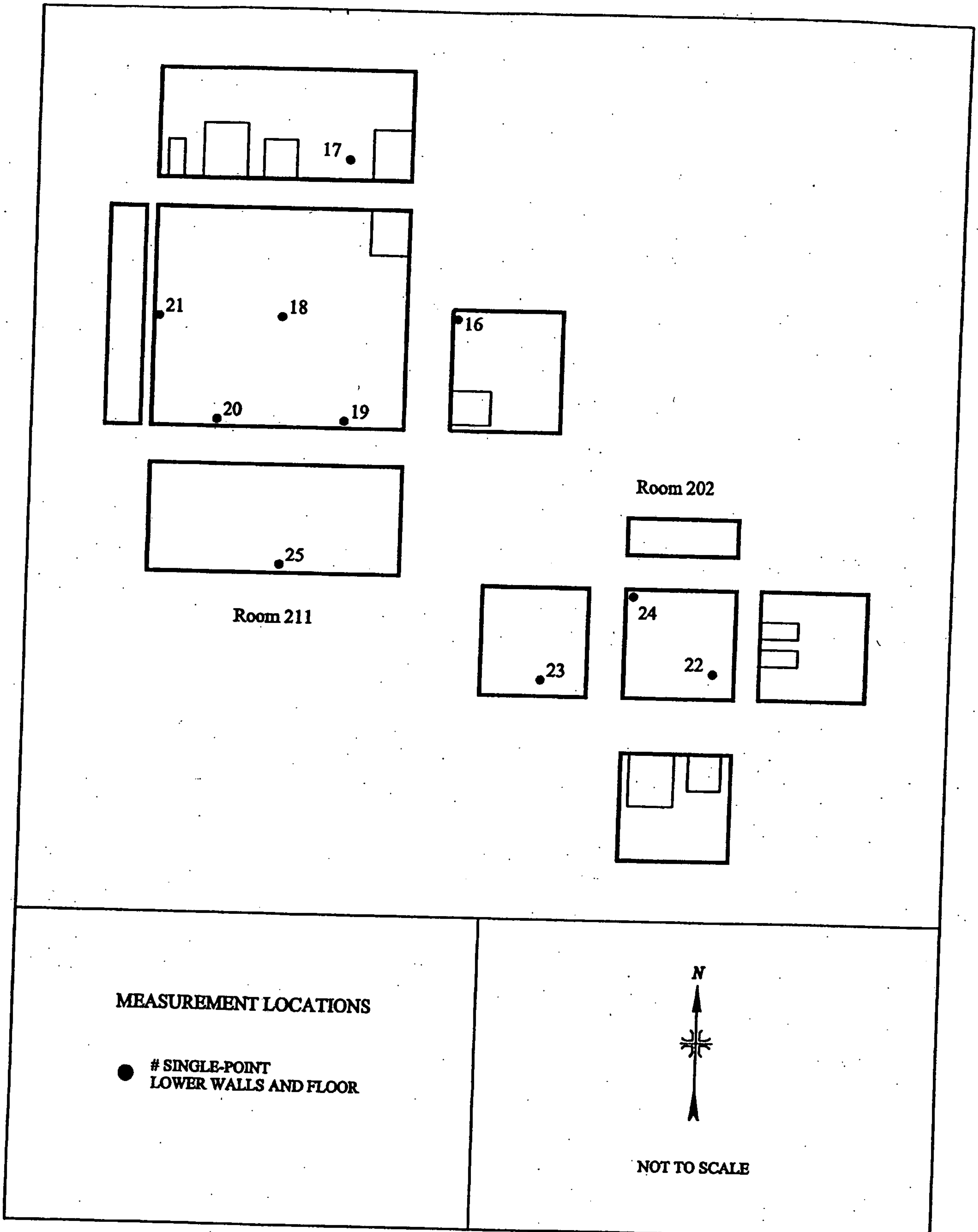

FIGURE 16: Survey Unit 776028 - Measurement Locations

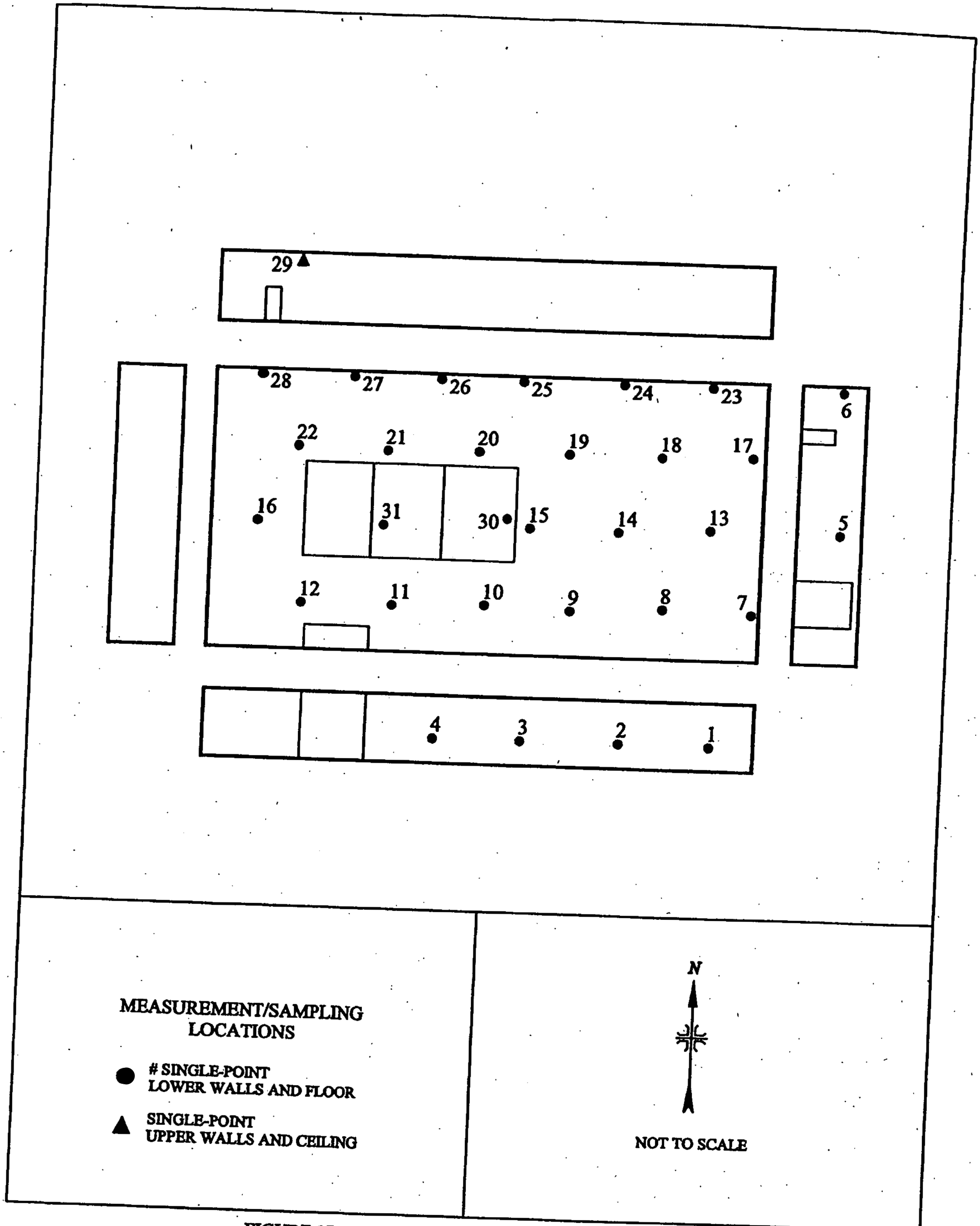

FIGURE 17: Survey Unit 776029 - Measurement Locations

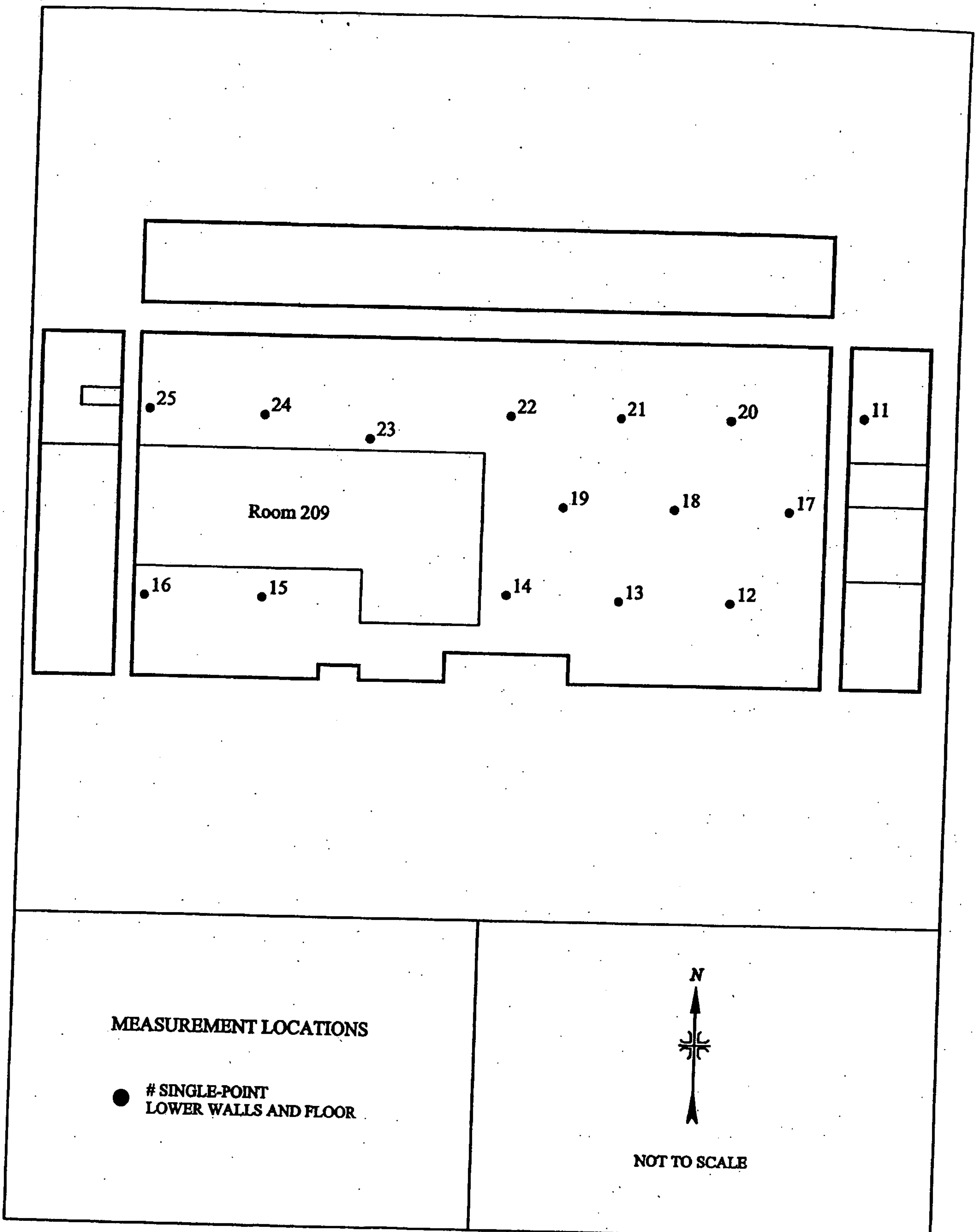

FIGURE 18: Survey Unit 776032 - Measurement Locations

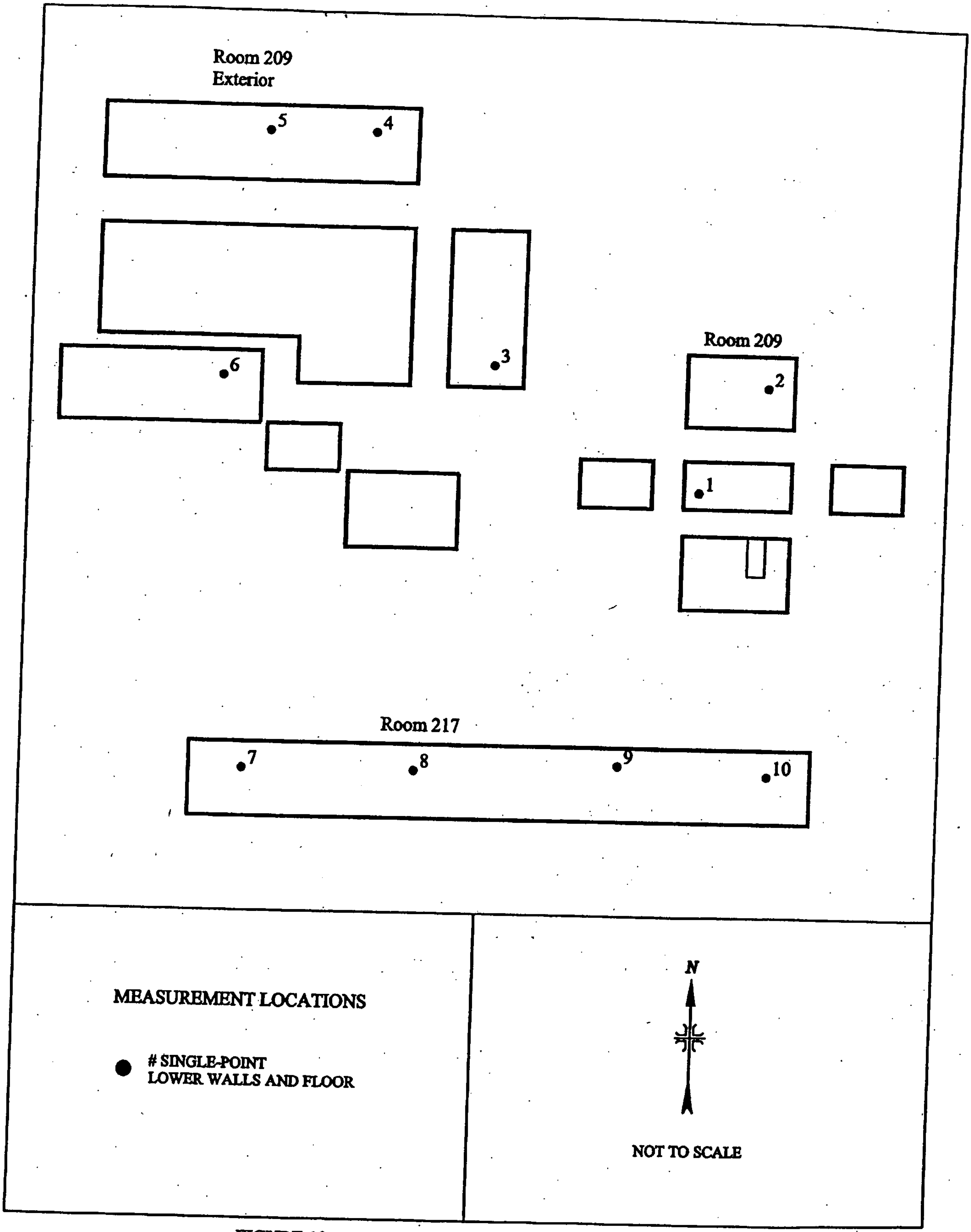

FIGURE 19: Survey Unit 776032 - Measurement Locations

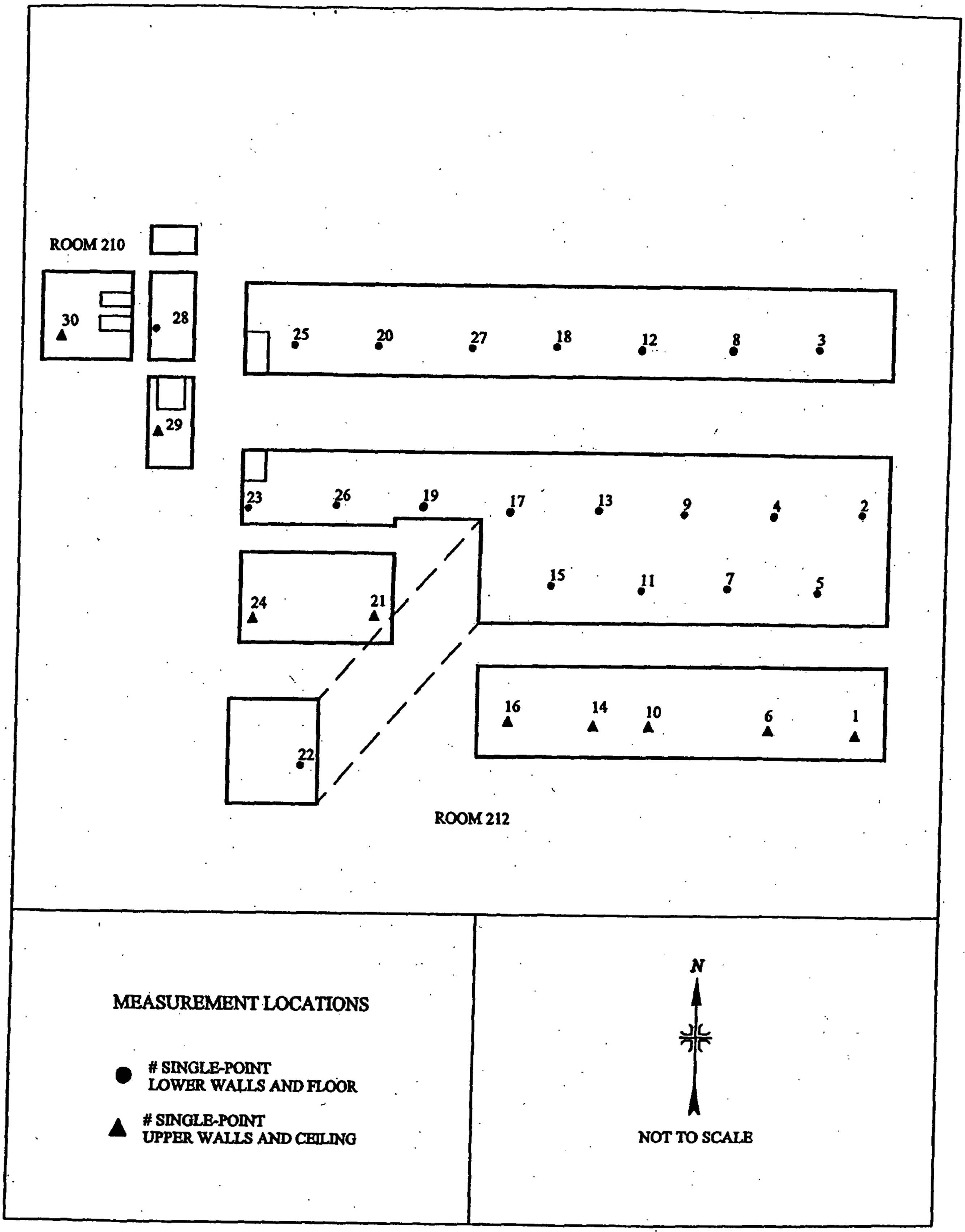

FIGURE 20: Survey Unit 776034 - Measurement Locations

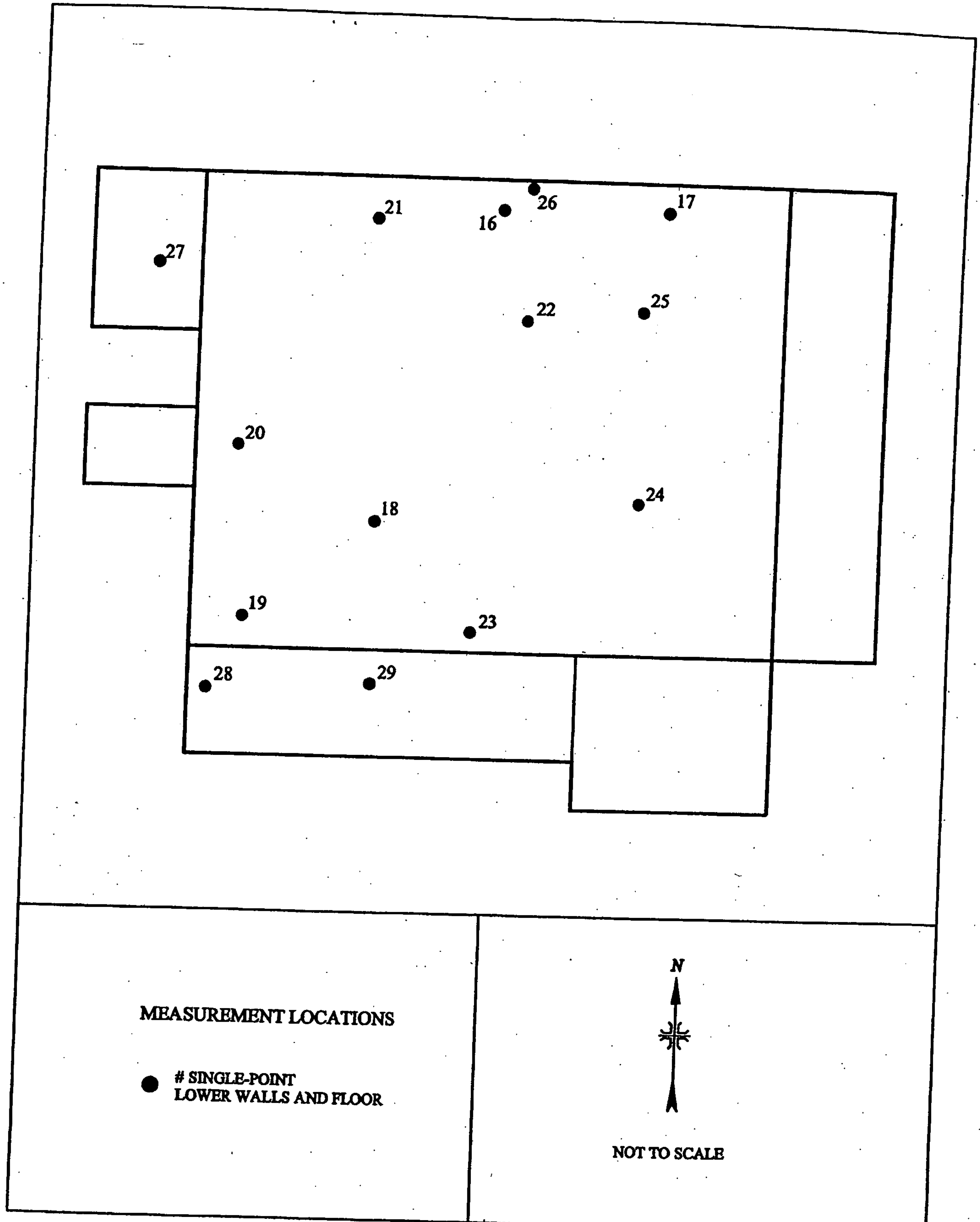

FIGURE 21: Survey Unit 776035 - Measurement Locations

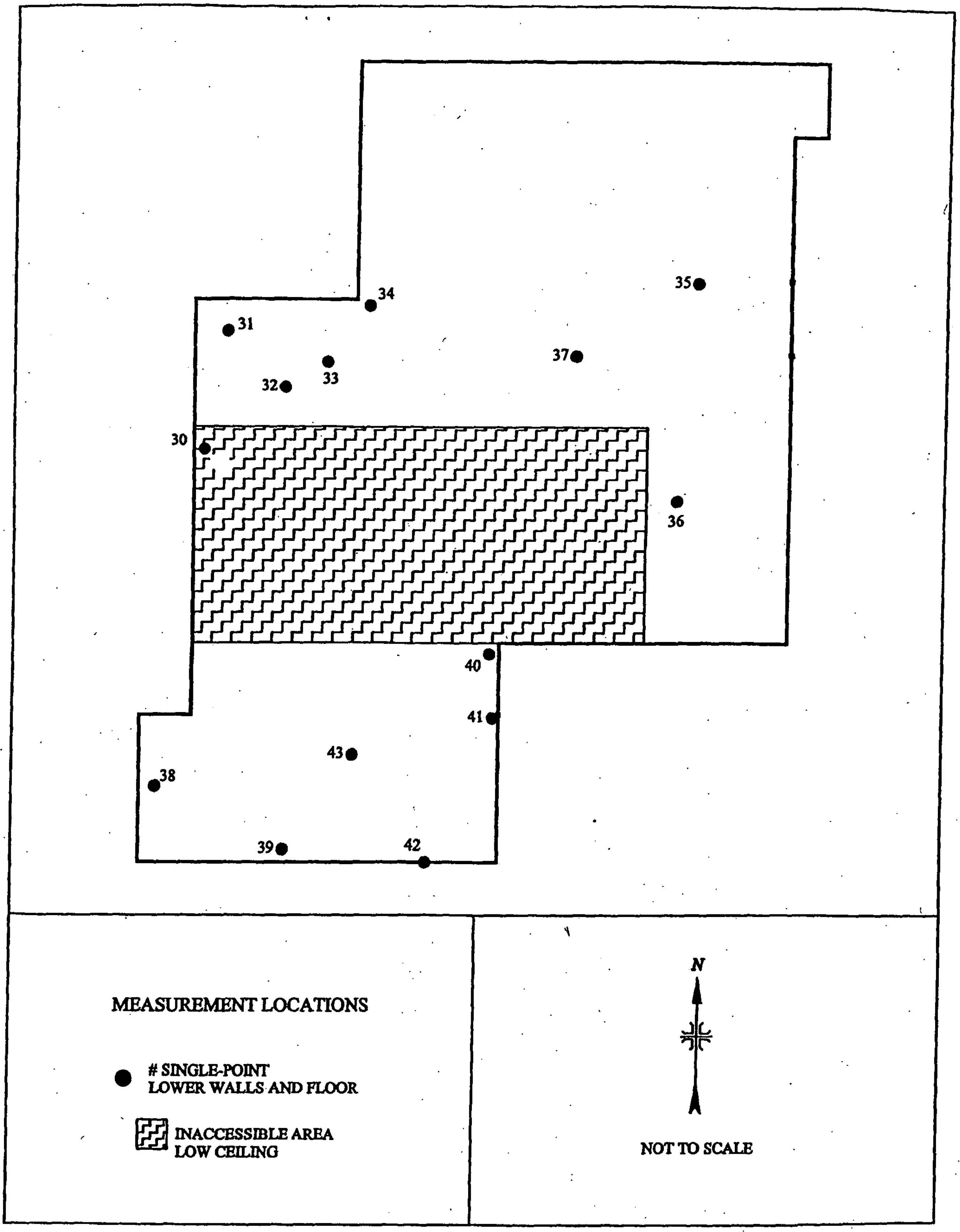

FIGURE 22: Survey Unit 776041 - Measurement Locations

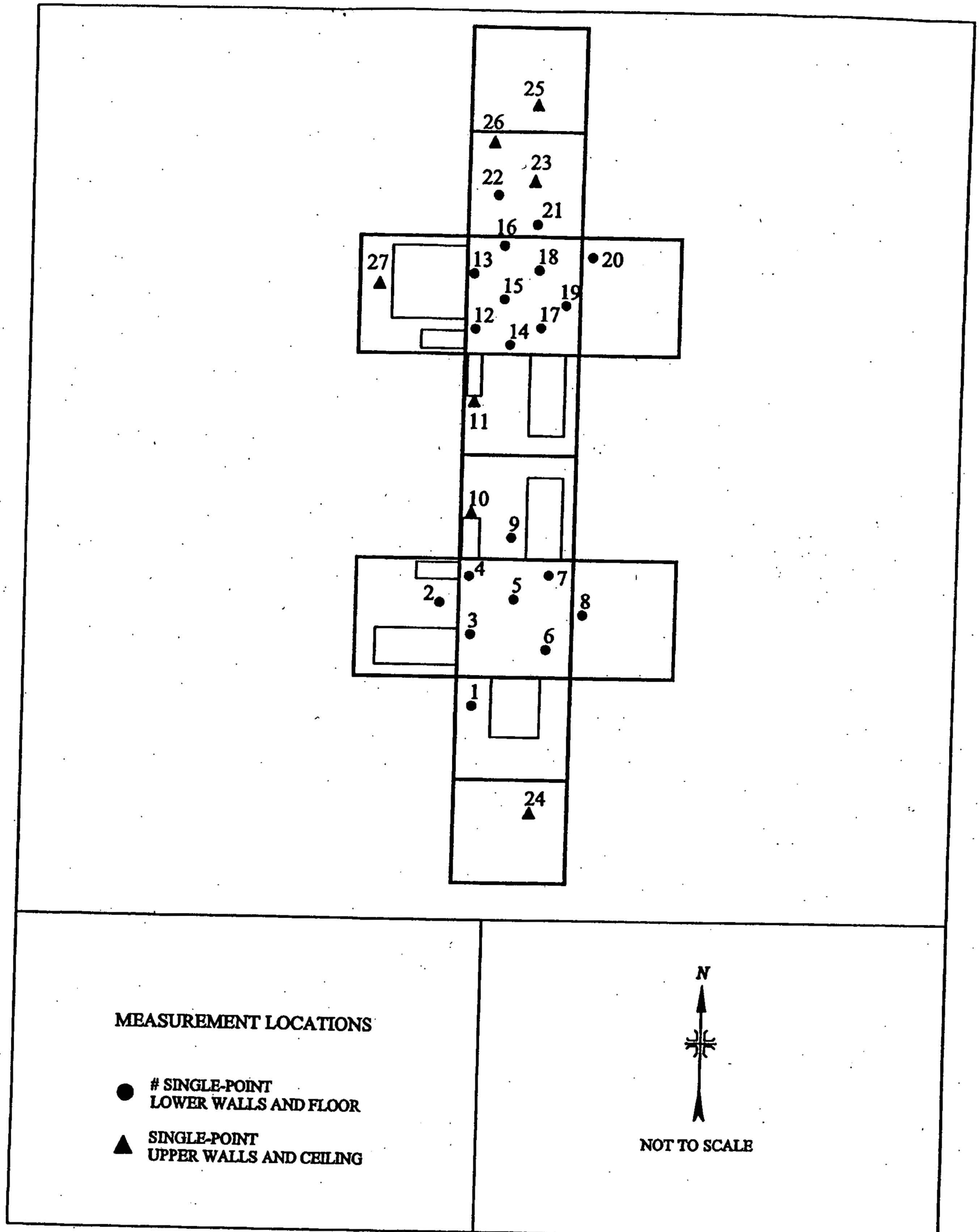

FIGURE 23: Survey Unit 776043 - Measurement Locations

TABLES

TABLE 1

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776002
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
1	-14,000	23,571
2	-58,000	9,890
3	-27,000	9,890
4	-20,000	9,890
5	-21,000	9,890
6	-8,600	9,890
7	80	9,890
8	12,000	9,890
9	24,000	9,890
10	-8,200	9,890
11	-9,400	9,890
12	-7,900	9,890
13	-10,000	9,890
14	-4,600	9,890
15	270,000	252,205
16	62,000	23,571
17	-140,000	9,963
18	-110,000	9,963
19	-130,000	9,963
20	-130,000	9,963
21	-87,000	9,963
22	-120,000	9,963
23	-130,000	9,963
24	-130,000	9,963
25	-88,000	7,530
26	-90,000	7,530

TABLE 1 (Continued)

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776002
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
27	-65,000	7,530
72	5,800,000	N/A[d]
73	1,600,000	N/A
74	1,900,000	N/A
75	900,000	N/A
76	1,900	N/A
77	560,000	N/A
78	38,000	N/A
79	850,000	N/A
80	-5,000	N/A
81	19,000	N/A
82	-41,000	N/A
83	42,000	N/A
84	10,000,000	N/A
85	2,000,000	N/A

[a]Refer to Figure 4.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.
[d]Not Available – activity calculations could not be performed due to lack of instrument-specific information.

TABLE 2

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776004
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location [a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2) [c]
1	-120,000	10,946
2	-110,000	10,946
3	-19,000	11,122
4	-10,000	11,122
5	7,600	11,122
6	-4,000	11,122
7	-13,000	11,122
8	1,100	11,122
9	-110,000	10,946
10	-140,000	10,946
11	-120,000	10,946
12	-140,000	10,946
13	-150,000	10,946
14	-37,000	10,946
15	-150,000	10,946
16	-98,000	10,946
17	34,000	51,516
18	-1,300	11,122
19	19,000	11,122
20	16,000	11,122

[a]Refer to Figure 5.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.

TABLE 3

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776007
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location [a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2) [c]
1	15,000	10,865
2	43,000	10,865
3	41,000	9,820
4	48,000	10,865
5	-59,000	9,820
6	65,000	10,865
7	28,000	10,865
8	-68,000	9,820
9	42,000	10,865
10	38,000	10,865
11	44,000	10,865
12	-69,000	9,820
13	93,000	10,865
14	-60,000	9,820
15	26,000	9,820
16	66,000	64,418
17	-21,000	9,820
18	56,000	10,865
19	43,000	39,346
20	5,200	10,865
21	67,000	11,163
22	81,000	46,575
23	75,000	43,830
24	64,000	9,820
25	52,000	16,562
26	64,000	11,529

TABLE 3 (Continued)

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776007
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location [a]	ESSAP Total Alpha Activity Using K-H Conversion Factors ($dpm/100\ cm^2$)[b]	K-H Total Alpha Activity ($dpm/100\ cm^2$)[c]
27	-11,000	9,820
28	53,000	10,865
29	54,000	9,820
30	-14,000	9,820

[a]Refer to Figure 6.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex
[c]Values less than MDC were reported as the MDC.

TABLE 4

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776008
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location [a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
1	-41,000	9,820
2	-58,000	9,820
3	110,000	88,392
4	19,000	9,820
5	81,000	18,301
6	4,200	9,820
7	48,000	10,523
8	-8,000	9,820
9	90,000	48,954
10	7,200	9,820
11	82,000	98,823
12	10,000	9,820
13	81,000	83,908
14	35,000	9,820
15	70,000	9,820
16	36,000	9,820
17	36,000	9,820
18	52,000	9,820
19	-50,000	9,820
20	-11,000	9,820
21	-64,000	9,820
22	100,000	9,820
23	77,000	43,189
24	-15,000	40,719

[a]Refer to Figure 7.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex
[c]Values less than MDC were reported as the MDC.

TABLE 5

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776011
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
20	56,000,000	N/A[d]
21	29,000,000	N/A
22	45,000,000	N/A
23	42,000,000	N/A
24	44,000,000	N/A
25	230,000	N/A
26	260,000	N/A
27	320,000	N/A
28	770,000	N/A

[a]Refer to Figure 8.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.
[d]Not Available – activity calculations could not be performed due to lack of instrument-specific information.

TABLE 6

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776012
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
44	6,100,000	N/A[d]
45	21,000,000	N/A
46	5,900,000	N/A
47	1,800,000	N/A
48	1,300,000	N/A
49	1,500,000	N/A
50	72,000	N/A
51	87,000	N/A
52	2,800,000	N/A
53	82,000	N/A
54	98,000	N/A
55	95,000	N/A
56	74,000	N/A
57	56,000	N/A
58	8,300,000	N/A
59	21,000,000	N/A
60	4,900,000	N/A
61	20,000,000	N/A
62	2,800,000	N/A
63	1,700,000	N/A
64	1,700,000	N/A
65	33,000,000	N/A
66	17,000,000	N/A
67	50,000,000	N/A
68	3,300,000	N/A
69	71,000,000	N/A
70	59,000	N/A
71	-50,000	N/A

[a]Refer to Figure 9.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.
[d]Not Available – activity calculations could not be performed due to lack of instrument-specific information.

TABLE 7

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNITS 776015 and 776018
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
1	7,200,000	7,700,000
2	760,000	810,000
3	700,000	820,000
4	1,200,000	1,400,000
5	56,000	43,000
6	80,000	57,000
7	730,000	740,000
8	4,000,000	9,200,000
9	2,200,000	3,000,000
10	230,000	250,000
11	4,500,000	5,200,000
12	32,000	65,000
13	330,000	300,000
14	580,000	600,000

[a]Refer to Figure 10.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.82 for the epoxy surface coating.
[c]Values less than MDC were reported as the MDC.

TABLE 8

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776019
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
1	1,800,000	N/A[d]
2	10,000,000	N/A
3	16,000,000	N/A
4	4,300,000	N/A
5	580,000	N/A
6	5,000,000	N/A
7	1,800,000	N/A
8	520,000	N/A
9	700,000	N/A
10	790,000	N/A
11	1,100,000	N/A
12	110,000	N/A
13	46,000	N/A
14	350,000	N/A
15	17,000	N/A

[a]Refer to Figure 11.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.82 for the epoxy surface coating.
[c]Values less than MDC were reported as the MDC.
[d]Not Available – activity calculations could not be performed due to lack of instrument-specific information.

TABLE 9

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776023
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)
30[d]	93,000	200,000
31[d]	34,000	32,000
32[d]	24,000	20,000
33[d]	53,000	18,000
34[d]	2,300	6,700
35[d]	-23,000[c]	9,900
36[d]	28,000	42,000
37[d]	21,000	24,000
38[d]	-2,500	20,000
39[d]	35,000	42,000
40[e] (core location M001)	280,000	N/A
41[e] (core location M008)	-11,000	N/A
42[e] (core location M003)	21,000	N/A
43[e] (core location M004)	40,000	N/A
44[e] (core location M005)	2,000,000	N/A
45[e] (core location M006)	520,000	N/A
46[e] (core location M007)	390,000	N/A
47[e] (core location M002)	1,200,000	N/A

[a]Refer to Figure 13.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.82 for the epoxy surface coating.
[c]Reported large negative value likely due to statistically low background measurement.
[d]Biased locations selected by DOE
[e]Pre-core sample measurements

TABLE 10

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNITS 776021 and 776023
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)
15	3,100,000	4,100,000
16	580,000	880,000
17	1,100,000	1,400,000
18	770,000	1,100,000
19	490,000	720,000

[a]Refer to Figures 12 and 13.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.82 for the epoxy surface coating.

TABLE 11

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776026
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location [a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
1	19,000	13,410
2	8,300	12,910
3	14,000	14,243
4	18,000	22,155
5	4,200	19,074
6	7,900	24,154
7	68,000	56,971
8	50,000	38,647
9	-120,000	8,938
10	-96,000	8,938
11	-82,000	8,938
12	-96,000	8,938
13	-140,000	8,938
14	-140,000	8,938
15	-120,000	8,938
16	-170,000	8,938
17	-55,000	6,701
18	-64,000	6,701
19	-57,000	6,701
20	-75,000	6,701

[a]Refer to Figure 14.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for the thin paint surface coating.
[c]Values less than MDC were reported as the MDC.

TABLE 12

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776028
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location [a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
1	36,000	10,889
2	-59,000	9,026
3	22,000	34,144
4	-43,000	9,026
5	13,000	9,026
6	-62,000	9,026
7	26,000	9,026
8	-35,000	9,026
9	23,000	17,294
10	-19,000	9,026
11	-65,000	9,026
12	-74,000	9,026
13	-73,000	9,026
14	-68,000	9,026
15	-69,000	9,026
16	-42,000	9,026
17	-24,000	9,026
18	-640	9,026
19	21,000	52,248
20	14,000	38,431
21	5,600	37,882
22	24,000	9,026
23	-38,000	9,026
24	7,300	9,026
25	32,000	39,621

[a]Refer to Figures 15-16.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for the thin paint surface coating.
[c]Values less than MDC were reported as the MDC.

TABLE 13

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776029
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location[a]	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[b]	K-H Total Alpha Activity (dpm/100 cm^2)[c]
1	-70,000	9,890
2	-84,000	9,890
3	-71,000	13,826
4	-92,000	9,890
5	-110,000	8,938
6	-120,000	9,890
7	-20,000	9,890
8	-18,000	19,324
9	-25,000	9,890
10	-21,000	9,890
11	-14,000	9,890
12	-18,000	8,938
13	-22,000	9,890
14	-38,000	13,576
15	-2,800	33,067
16	-35,000	9,890
17	-37,000	8,938
18	-53,000	9,890
19	-36,000	96,534
20	-34,000	9,890
21	-36,000	8,938
22	-36,000	12,993
23	140,000	183,657
24	-36,000	13,493
25	-67,000	8,938
26	-40,000	11,994
27	-36,000	13,826
28	-25,000	9,890
29	-96,000	8,938
30	-7,200	35,982
31	1,300	9,890

[a]Refer to Figure 17.
[b]IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.

TABLE 14

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776032
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[a]	K-H Total Alpha Activity (dpm/100 cm^2)
1	150,000	108,778
2	-92,000	9,890
3	-79,000	25,154
4	-94,000	9,890
5	-83,000	22,489
6	-32,000	9,890
7	-65,000	9,890
8	-90,000	17,325
9	-89,000	9,890
10	-88,000	9,890
11	-120,000	9,890
12	-44,000	8,938
13	-24,000	9,890
14	-17,000	28,152
15	3,900	68,715
16	-31,000	9,890
17	-26,000	28,735
18	-68,000	9,890
19	-25,000	97,784
20	-20,000	9,890
21	-88,000	8,938
22	-23,000	19,907
23	-30,000	24,737
24	170,000	154,921
25	110,000	153,838

[a]Refer to Figures 18-19.
[b] IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.

TABLE 15

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776034
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[a]	K-H Total Alpha Activity (dpm/100 cm^2)
1	26,000	39,163
2	-4,200	9,026
3	-47,000	9,026
4	2,700	38,797
5	-1,800	9,026
6	20,000	41,542
7	-700	9,026
8	-44,000	9,026
9	14,000	9,026
10	35,000	9,026
11	14,000	9,026
12	-55,000	9,026
13	16,000	9,026
14	32,000	9,026
15	7,000	9,026
16	34,000	45,385
17	16,000	10,614
18	-63,000	9,026
19	39,000	59,934
20	-58,000	9,026
21	-72,000	9,026
22	-83,000	9,026
23	26,000	9,026
24	-70,000	9,026
25	-58,000	9,026
26	30,000	9,026
27	-57,000	9,026
28	20,000	71,738
29	-72,000	9,026
30	-51,000	12,627

[a] Refer to Figure 20.
[b] IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c] Values less than MDC were reported as the MDC.

TABLE 16

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776035
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[a]	K-H Total Alpha Activity (dpm/100 cm^2)
16	170,000	N/A[d]
17	210,000	N/A
18	1,700,000	N/A
19	22,000	N/A
20	37,000	N/A
21	28,000	N/A
22	20,000	N/A
23	39,000	N/A
24	8,800	N/A
25	16,000	N/A
26	-5,000	N/A
27	25,000	N/A
28	23,000	N/A
29	19,000	N/A

[a]Refer to Figure 21.
[b] IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.
[d]Not Available – activity calculations could not be performed due to lack of instrument-specific information.

TABLE 17

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776041
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[a]	K-H Total Alpha Activity (dpm/100 cm^2)
30	5,000,000	N/A[d]
31	890,000	N/A
32	2,600,000	N/A
33	950,000	N/A
34	53,000	N/A
35	120,000	N/A
36	190,000	N/A
37	-30,000	N/A
38	300,000	N/A
39	-30,000	N/A
40	-4,000	N/A
41	-20,000	N/A
42	-20,000	N/A
43	-20,000	N/A

[a]Refer to Figure 22.
[b] IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.
[d]Not Available – activity calculations could not be performed due to lack of instrument-specific information.

TABLE 18

SURFACE ACTIVITY COMPARISON MEASUREMENTS
SURVEY UNIT 776043
BUILDING 776/777 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Measurement Location	ESSAP Total Alpha Activity Using K-H Conversion Factors (dpm/100 cm^2)[a]	K-H Total Alpha Activity (dpm/100 cm^2)
1	-79,000	7,438
2	-100,000	7,438
3	-26,000	7,438
4	300,000	261,724
5	-30,000	20,339
6	-75,000	7,438
7	-57,000	7,438
8	-84,000	7,438
9	-97,000	7,438
10	-100,000	7,438
11	-110,000	7,438
12	-91,000	7,438
13	-76,000	7,438
14	-91,000	7,438
15	-87,000	7,438
16	-71,000	7,438
17	-89,000	7,438
18	-69,000	N/A
19	200,000	255,253
20	-32,000	125,546
21	-74,000	10,435
22	-88,000	10,435
23	-77,000	10,435
24	-17,000	10,435
25	-30,000	28,382
26	-95,000	72,295
27	-100,000	10,435

[a]Refer to Figure 23.
[b] IVT total alpha activity measurement conversions used the K-H Pu to Am-241 ratio of 8.1 multiplier and the K-H attenuation factor of 0.997 for either no overlying material or a thin layer of latex.
[c]Values less than MDC were reported as the MDC.

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APPENDIX A

MAJOR INSTRUMENTATION

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MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Gamma

Ludlum Ratemeter-Scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to
BICRON NaI Scintillation Detector
Model G5 FIDLER
(Bicron Corporation, Newburg, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

Low Background Gas Proportional Counter
Model LB-5100-W
(Canberra/Tennelec, Oak Ridge, TN)

Alpha Spectrometry System
Tennelec Model 256
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors
(Canberra, Meriden, CT) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden,CT)

Alpha Spectrometry System
Canberra Model 7401VR
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
CANBERRA/Tennelec Model No: ERVDS30-25195
(Canberra, Meriden, CT)

LABORATORY ANALYTICAL INSTRUMENTATION (CONTINUED)

Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(EG&G ORTEC, OAK RIDGE, TN)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
DEC ALPHA Workstation
(Canberra, Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

A walkdown of the project area was performed to evaluate the survey areas for potential health and safety issues that may not have been identified by the site. Additionally, the proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in applicable job hazard analyses (JHAs). The procedures entailed minimal potential hazards that were currently addressed in ESSAP JHAs.

Personnel adhered to the site health and safety requirements. Project training requirements were met prior to entry into the survey areas. General employee radiological training for site access was completed and the IVT completed beryllium worker qualification, including on-site physical, chest x-ray, and classroom lecture. In addition, the IVT received building specific entry and safety requirements. Confirmatory survey activities were conducted in areas that were not downposted for radiation or beryllium contamination and site dosimetric considerations were applicable.

QUALITY ASSURANCE

Calibration

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the ESSAP:

- Survey Procedures Manual (September 2004)
- Laboratory Procedures Manual (August 2004)
- Quality Assurance Manual (August 2004)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1C and the U.S. Nuclear Regulatory

Commission Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards and contain measures to assess processes during their performance. Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Instrumentation had to be re-calibrated at the site because of the effect of altitude on detection capability.

The gamma calibration efficiency for the FIDLER detector was determined to ISO-7503 recommendations. A NIST traceable Am-241 calibration source (maximum gamma energy of 59.5 KeV) was used to develop the optimal instrument efficiency using a 4π source activity. The calculated ε_{total} ranged from 0.08 to 0.11 depending on the detector. The calibration source emission rates were corrected for geometry when a source larger than the detector was used.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detector slowly over the surface. The distance between the detectors and surface was maintained at a minimum, nominally about 1 cm. Surfaces were scanned using a low-energy photon FIDLER detector with a detector area 127 cm^2. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument.

Specific scan MDCs for the NaI scintillation detector for the radionuclide mixture in concrete were not determined as the instrument was used solely as a qualitative means to identify elevated gamma activity however, MDCs for radionuclides in the concrete would approximate those contained in NUREG-1507.

Surface Activity Measurements

Gamma surface activity measurements were performed using a FIDLER detector. Measurements were obtained in count rates integrated over a one minute interval. The net count rate was obtained by subtracting a material specific background count rate from the gross count rate. The net count rate was converted to nCi/g for Pu-239 concentration by dividing by the detector geometry and 4π efficiency which was then multiplied by the ratio of Am-241 to total Pu.

Gamma count rates were integrated over one minute using the FIDLER. Count rates (cpm) were converted to nanocuries per gram (nCi/g) using the following equation:

$$\left(\frac{cpm}{\varepsilon_T * \varepsilon_p * 127cm^2}\right) * \left(\frac{127\ m^2}{W}\right) * \left(\frac{nCi}{2220dpm}\right) * 8\frac{Pu}{Am}$$

where:

cpm = Net cpm (gross cpm−background cpm)
ε_T = Total Efficiency = 0.08
ε_p = Attenuation Correction Factor for Painted Surfaces = 0.679

W = Volume * Density of Concrete = 127cm^2 * 1 cm * 2.35 g/cm^3 = 298.45 g

Note: Volume is calculated as physical detector area x DCGL depth

8 = ratio of Pu-239 to Am-241 for 35-year old WGP